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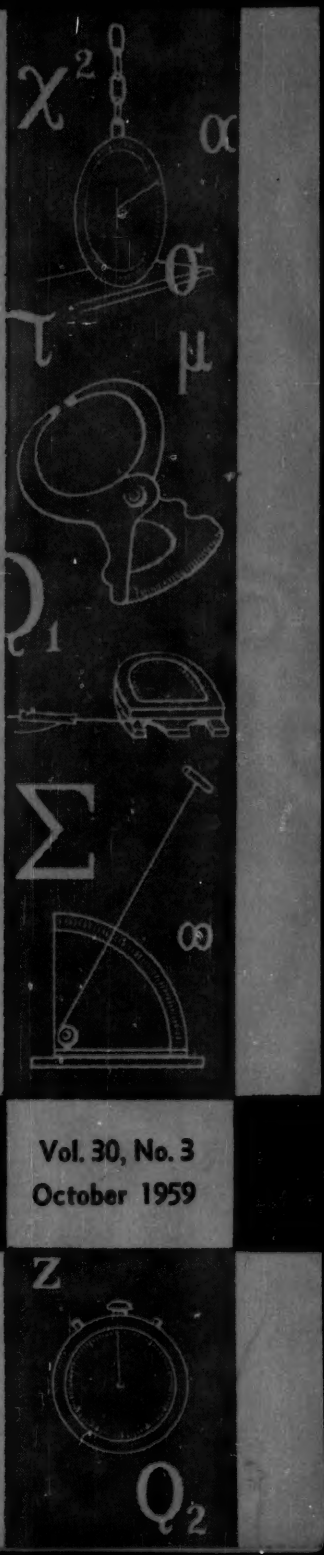

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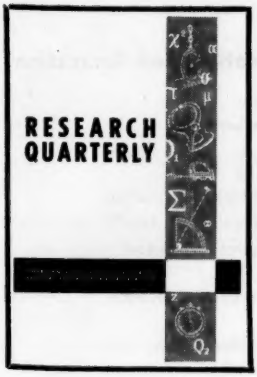

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Rhythmic Perception and Gross Motor Performance[1]

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Abstract

The primary problem was to determine relationships between three different forms of rhythmic perception and tests of motor performance. A subsidiary problem was the construction of the A-V-T Apparatus for the projection of rhythmic patterns from the Seashore Test of Rhythm, in aural, visual, and tactile media. Results of the study indicate the feasibility of projection of rhythmic patterns in several sensory media but do not indicate a significant relationship to objective measures of motor performance or motor learning. Apparently further experimentation utilizing the traditional concept of rhythmic perception as ability to perceive periodic successions is not likely to prove fruitful.

AMONG PERSONS INTERESTED in various aspects of physical performance, the assumption that rhythm is a factor in learning and performing motor skills has often been taken for granted. However, there has been no general agreement about the exact nature of this rhythmic factor, the extent of its influence on motor ability, or the ways in which it is related to motor educability. It has also been assumed that rhythm can be perceived in various ways, since all of the senses are capable of experiencing a rhythmic organization of sensations.

This study was undertaken as an attempt to explore various forms of rhythmic perception as possible correlates of motor performance. The interrelationships among rhythmic perception, intelligence, and the ability to learn a new motor skill were also examined.

The Problem

The primary problem was to ascertain relationships among three different forms of rhythmic perception and performance on certain selected tests of motor ability, motor capacity, and motor educability. The relationships between rhythmic perception and certain measures of intelligence were also determined.

Since no instrument was available for the projection of rhythmic patterns in order that visual, aural, and tactile perceptions might be measured, the construction of an electronic device for such purposes of projection was a subsidiary problem.

Subjects for the study were 78 American-Negro girls in grades 9 through 12 attending Jefferson High School in Los Angeles. The measures of rhyth-

[1] This study was made in partial fulfillment of requirements for the degree of Doctor of Philosophy, Graduate School, University of Southern California.

mic perception used were the Test of Rhythm from the revised *Seashore Measures of Musical Talents* (11), adapted for projection on the electronic apparatus.

Five measures of motor performance included the Sargent Jump as a measure of power; a 60-yard dash for the measure of speed; a basketball throw for distance as a combined measure of strength, co-ordination, and insight; the lie-sit-stand for a measure of agility; and the Iowa Revision of the Brace Test as a measure of educability.

Initial and final performance levels in table tennis were measured by the Mott-Lockhart Backboard Test (8). The difference was used as the measure of ability to learn an unfamiliar sports skill. In addition, measures of intelligence, reading ability, and sight were employed in the study. Scores were obtained from the California Mental Maturity Intelligence Test, the California Reading Test, and a test of vision.

Measures of Rhythmic Perception

Rhythm is defined in this paper as a patterned cycle of events. The Seashore Test of Rhythm has been constructed upon these principles of periodic succession. This test was the pioneer work on aptitude testing in the field of music, having been recorded first in 1919 and revised in 1939. The test is composed of 30 rhythmic patterns played twice in either the same or altered form. The subject classified each pattern as "same" or "different."

Of the studies found which were concerned with relationships between rhythmic perception and motor performance, the Seashore Test of Rhythm was the most frequently employed tool for measuring rhythmic perception. Annett (1), Lemon and Sherbon (6), Wettstone (15), Benton (2), and Dillon (3) found correlations ranging from —.10 to .48 when various measures of motor performance were correlated with the Seashore Test.

Several research studies appeared between 1930 and 1940 dealing with rhythmic perception in Negroes, which, for the most part, employed the Seashore sensory-rhythm test. Johnson (4), Peterson and Lanier (9), Streep (12), and Sanderson (10) found that Negroes showed a slight, although not statistically significant, superiority to the whites.

Construction of Apparatus

Collaboration with an electronic consultant determined that an apparatus could be constructed which would (a) project rhythmic patterns that could be seen, heard, and felt and (b) satisfy the requirements of objectivity and reliability. The design incorporated a turntable on which discs could be played as on an ordinary electrical phonograph. The Seashore Test of Rhythm could be transcribed upon these discs by punching out holes in patterns determined by the test. When the disc revolved, impressions would be picked up for projection by means of light sensitive cells which would activate a bell, a light, or a vibrator.

In its finished form, the Aural-Visual-Tactile Testing Apparatus consisted of a turntable and motor, two primary signal pick-ups with light sources, and three secondary signal transmitters consisting of bell, light, and vibrator. A synchronous A.C. electric motor produced a constant speed in the turntable. Speed of the motor was reduced by a transmission to one revolution in 27 seconds.

Two light sources of 2.2 volts each were used. A step-down transformer lowered the voltage from 117 volts to 2.2 volts. An intense, concentrated beam was given by the bulbs, thus making it possible to use a small and compact electric unit. Two signal pick-ups were added which consisted of self-generating photo or selenium cells. A small voltage was generated by these cells when light was transmitted by the disc holes from its source beneath the selenium cells. When a hole passed between light and cell the emitted light activated the cell. With the passing of a series of holes, the transcribed patterns of the Seashore Test appeared.

Hearing aid batteries provided the current. Two electronic amplifier units amplified the minute signals from the photo cells in order to operate the relays which in turn activated the A-V-T signals. The transformer had two separate windings, one at 6.3 volts and the other at 4.5 volts, giving a 1.8 variance. The purpose of the two separate voltages was to include an accent which appears in the Seashore Test. The higher voltage provided greater stimulus intensity on each of the three signals—the aural, visual, and tactile. An oscilloscope reading showed a difference of 4.5db between the accented and unaccented notes on the Seashore recording of the rhythm test. This difference conformed to Saetweit's (11: 12) recommendation regarding decibel variance.

A selector switch provided a means of channeling the incoming signals to the A-V-T receptors. The aural signal used was a bell. A prefocused white incandescent pilot light flashed the patterns visually. Production of the tactile signal was achieved through the use of a D.C. relay coil activated by a varying A.C. current. Voltage applied to this relay caused the armature to vibrate at the same frequency as the applied voltage, which was 60 cycles. The intensity of the tactile signal was proportional to the applied voltage. Vibrations signaled the rhythmic patterns to a metal plate appearing on top of a small wooden box. Vibrations could then be felt by placing the fingers upon this plate. A clock was

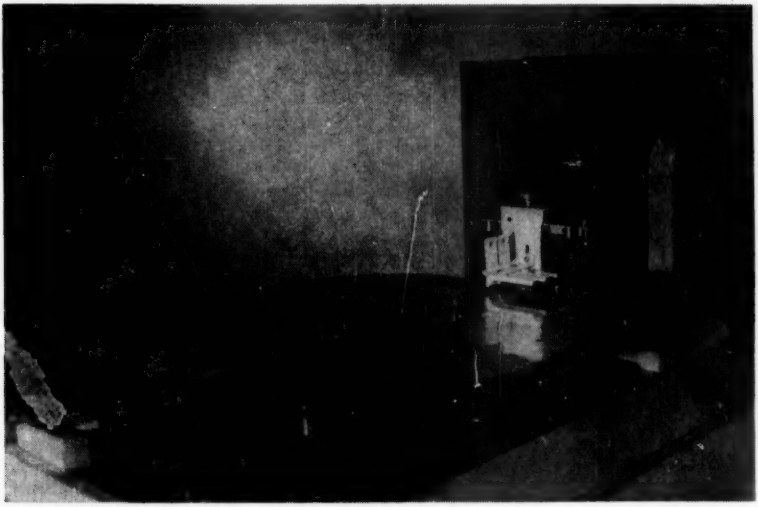

FIGURE I. The aural-visual-tactile apparatus complete with disc.

installed on the face of the control box to aid the operator in presenting the A-V-T tests. Finally, a momentary and continuous spring switch enabled the operator to start and stop the instrument at will. In this way each test item could be produced separately.

The rhythmic patterns were inscribed on eight 15-inch metal discs of narrow gauge aluminum. Aluminum foil was chosen because, in addition to the requisite of a narrow gauge, it was light in weight and durable, as well as opaque, plastic, ductile, rust-proof, and relatively inexpensive. Two concentric circles or round holes were punched through the metal. Hole diameters in each circle corresponded to two degrees of a circle at their respective radii. A 3/16-inch circle diameter was determined to be the smallest space through which sufficient light could be emitted to ensure contact with the cell.

Note value in terms of distance was determined by arithmetical progression. Two degrees of a circle served as the constant. A sixteenth note was represented by two degrees, an eighth note by four, a dotted eighth note by six, and a quarter note by eight degrees. Further, one degree was alloted between two notes as the necessary interval to stop contact by the signal pick-ups after contact was made. Holes comprising the outermost circles had a one-quarter-inch diameter and were placed one-quarter inch in from the disc circumference. The second row of holes was placed three-eighths of an inch toward the disc's center from this first row. At three-sixteenth's of an inch diameter, these inner holes were equal in time duration upon revolving to the outer row, due to the slower speed of the disc at this shorter radius. Accents were represented by the inner circle of holes, while the outer circle exemplified the unaccented notes. The Seashore Rhythm Test is composed of three distinct sections which differ in length of pattern by an additional note. Between each of the two parts of a pattern, seven degrees were required for correspondence to the Seashore recording. The operator allotted the necessary three and one-half seconds between patterns as well as the seven-second period between groups.

Method

All 78 subjects were given the rhythm test in its four forms and the five tests of motor performance. Thirty-one of these subjects were novices at table tennis and participated in 15 half-hour periods of instruction and practice in the learning experiment.

Analysis of the Data

Reliability of the tests of rhythmic perception was determined by the split-halves method, using the Spearman-Brown formula for correction. Interrelationships among the various tests were studied by means of the Pearson Product-Moment method of correlation.

The rhythm tests were administered in differing sequences for random halves of the total group. Using the formula for Fisher's t for uncorrelated small samples, differences between the groups were found to be not statistically significant.

In the table tennis experiment the difference between the means for measures of initial and final performance was statistically significant, indicating that learning did occur.

Findings

1. Reliability of the A-V-T projections of the Seashore Test (.42 to .51) was somewhat lower than that of the Seashore Test as administered in this experiment (.64).
2. Intercorrelations between tests of rhythmic perception ranged from .31 ± .10 to .71 ± .06, the highest being between the tactile projection and the original Seashore form of the test (r = .60) and between the tactile and aural forms of the test (r = .71).
3. Only two statistically significant correlations were found between the measures of rhythmic perception and measures of motor performance, and these were too low to have predictive value. These were between visual perception and the Sargent Jump (r = .32 ± .10) and between tactile perception and the lie-sit-stand (r = .30 ± .10).
4. Correlation measures of rhythmic perception and motor learning in the table tennis learning experiment were not statistically significant.
5. Low but statistically significant correlations ranging from .24 to .36 were found between IQ and the measures of rhythmic perception.
6. Correlations between IQ and measures of motor performance were essentially zero.

Conclusions

Within the limitations of the present experimental study and related studies reported by other investigators, it has been demonstrated that (a) measures of rhythm based on the concept of periodic succession can be projected satisfactorily in several sensory media, including tactile and visual as well as aural perception and (b) scores made on such aural, visual, and tactile rhythmic perception tests are not significantly related to objective measures of motor performance or motor learning.

Discussion

These repeated findings concerning the apparent lack of any statistically verifiable relationship between "rhythmic perception" and "motor performance" do not necessarily preclude the possibility that such relationship exists. Rather they suggest the conclusion that further exploration of rhythmical components of co-ordinated motor performance, utilizing the traditional con-

TABLE 1.—INTERCORRELATION COEFFICIENTS AND COEFFICIENTS OF RELIABILITY FOR TESTS OF RHYTHMIC PERCEPTION

	Seashore	Aural	Visual	Tactile
Seashore	.64[a]			
Aural	.48 ± .09	.42[a]		
Visual	.42 ± .09	.34 ± .10	.50[a]	
Tactile	.60 ± .07	.71 ± .06	.31 ± .10	.51[a]

[a]Reliability computed by the split-halves method, using the Spearman-Brown formula for correction.

TABLE 2.—CORRELATION COEFFICIENTS BETWEEN MEASURES OF MOTOR PERFORMANCE AND MEASURES OF RHYTHMIC PERCEPTION

	Seashore	Aural	Visual	Tactile	Rhythm Composite Score
Lie-Sit-Stand	.04 ± .11	.02 ± .11	.16 ± .11	.30 ± .10	−.18 ± .11
Sargent Jump	.28 ± .17	.12 ± .11	.32 ± .10	.01 ± .11	.16 ± .11
Basketball Throw	.23 ± .11	.14 ± .11	.07 ± .11	.16 ± .11	.15 ± .11
60-Yard Dash	.02 ± .11	−.05 ± .11	.03 ± .11	.14 ± .11	.07 ± .11
Iowa-Brace	.06 ± .11	.04 ± .11	.07 ± .11	−.24 ± .11	.01 ± .11
Motor Composite Score	.22 ± .11	.06 ± .11	.24 ± .11	.06 ± .11	.06 ± .11

TABLE 3.—CORRELATION COEFFICIENTS BETWEEN TABLE TENNIS SCORES AND MEASURES OF MOTOR PERFORMANCE AND RHYTHMIC PERCEPTION

	Table Tennis Ability		
	Initial	Final	Learning Score
Lie-Sit-Stand	.16 ± .17	.30 ± .16	.04 ± .18
Sargent Jump	.34 ± .16	.07 ± .18	.26 ± .17
Basketball Throw	.78 ± .07	.60 ± .12	.37 ± .15
60-Yard Dash	.36 ± .16	.16 ± .17	.01 ± .18
Iowa-Brace	.06 ± .17	.02 ± .18	.23 ± .17
Motor Composite Score	.40 ± .15	.25 ± .17	.16 ± .17
Seashore	.28 ± .17	.17 ± .17	.18 ± .17
Aural	.19 ± .17	.004 ± .18	.24 ± .17
Visual	.15 ± .18	.13 ± .18	.28 ± .17
Tactile	.15 ± .18	.12 ± .18	.04 ± .18
Rhythm Composite Score	.17 ± .17	.10 ± .18	.16 ± .17

cept of rhythmic perception as ability to perceive periodic successions, is not likely to prove fruitful.

The rhythmic components which are integrated to produce co-ordinated motor performance may involve the ability to perceive the specialized form of rhythm expressed in simple periodic successions of visual, aural, or tactile events, but the multiplicity of rhythmic components and the complexity of their integrated interrelationships are such that isolation of a single element, such as ability to perceive periodic successions, provides little insight into the nature of the integrated whole.

It appears that a new approach is needed to this complex problem of rhythmical interaction dealing with human beings in motion. The view of rhythm as a functional involvement of successive events as presented by Langer (5) suggests leads for future investigation in this area of relationships between rhythmic perception and motor performance.

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(Submitted 12/5/58)

Physical Training Helps to Regulate and Improve Glandular Functions: A Review of Research[1]

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Importance of the Glands

Man's ability to keep his glands functioning normally probably determines, more than anything else, his endurance, vigor, disposition for exercise, and sexual ability (9, 19, 56, 57). The intimate association of all of these with youthfulness has long been assumed. The implications are directly that if man can find the way to keep his glands functioning properly and over a relatively long span of time, he will certainly locate the "Fountain of Youth." Recent studies at the University of Washington Medical School, in St. Louis, reported by William H. Masters (28), indicate that the feeding of the right proportion of hormones to older women made them feel and appear younger, re-established genital functions which had deteriorated, induced greater psychological interest and acuteness, and led to improved sense of cleanliness and well-being. The key to this work was administering female and male hormones (the female hormone is an estrogen and the male hormone testosterone) in the proportion of 1 to 20 (28, 68).

The literature on animal experimentation shows important connections between glandular functioning and all of the aspects of health and behavior named (32, 45, 59, 60). In our work with human subjects it is strongly indicated that progressive physical training, gradually up to the near all-out endurance level, influences the glandular functions. Whether or not this is due to the psychological effects of releasing tensions cannot be said. It is probably due also to improved circulation, to relatively higher metabolism, and to better nutrition as well, all of which are associated with a well-graduated program of progressive endurance training which lasts long enough to permit these physiological adjustments and adaptations to occur.

The conditioning of the muscles can be accomplished by adding a little to the overload, day by day. The circulatory-respiratory system is likewise affected. The key theoretical point is that glandular functioning is interrelated to circulatory functioning. It is obvious that improving the circulatory tone and turnover and opening up better circulation to glands which

[1]The writer acknowledges the critical appraisal of this article by G. E. Wakerlin, Ernst Jokl, and F. R. Steggerda.

may not have been too well supplied should improve their health and capacity to function. All nutritive elements and oxygen are borne by the circulation. It is an established fact that physical exercise challenges the circulation and the glandular system, especially the adrenal cortex.

Since all of the glands are linked in what may be called the "Central Glandular Axis," a stimulus to one gland will cause interactions with the other glands (45). A mild overload to the circulatory-respiratory and muscular systems will serve to challenge the glands into action, which, if increased gradually day by day but not overdone, may gradually train the glandular and circulatory systems by exercise. This would also apply to conditioning the reactions of the stomach, the intestines, and the sexual apparatus (1, 17, 24c, 69).

The major biological principle involved is that "function stimulates development or response." It seems very obvious from personal testimony of many men that better metabolism, as well as improved sex function, digestion, and excretion, are associated with the progressive type of physical training program. The evidence for this should be briefly reviewed.

Trends of the Evidence for Improved Circulatory and Glandular Functioning

Data, mainly from the Physical Fitness Research Laboratory, University of Illinois, Urbana, show that moderate, progressive, rhythmic endurance exercise programs (as in swimming, cycling, walking, jogging, and rhythmic conditioning calisthenics exercises) cause marked improvement in the circulatory-respiratory functions and in several of the associated glandular functions. Selye's work in stress has shown that the heart, glands, stomach, and intestines are interlinked, most probably by the autonomic nervous system, and respond in an associated way to severe stress (1, 24c, 59, 60).

The laboratory evidence has shown that progressive training in endurance exercises over several months or years causes the following types of responses: (a) enlarged T-Waves and R-Waves of the CR-IV and CR-V leads of the electrocardiogram (24b, 22, 63); (b) enlarged brachial sphygmograms (heartographs on the Cameron heartometer) (24b, 21);; (c) larger stroke volume of the heart with relatively faster ejection of blood into the large arteries (18, 24b, 46); (d) dilatation of the lung and muscular capillary beds, as evidenced by increased oxygen intake and circulation and lowered diastolic pressure after exercise (24, 25, 27); (e) improved endurance in test exercises (20); (f) increased basal metabolism in those who were low at the beginning of the training program (6, 23, 49); (g) increased tone of the vagus and also certain sympathetic branches of the autonomic nervous system which constrict the skin and splanchnic capillaries and dilate the deep capillaries in the muscles (10, 18, 24b, 21); (h) detection of faster flicker in the flicker fusion frequency test (10, 18); and (i) reduction of serum cholesterol in the blood (30, 51).

Physical exercise produces relatively faster blood flow through the lung

capillaries and pulmonary veins leading from the lungs to the left auricle of the heart. This is indicated by the larger oxygen intake at rest and in work, which is highly correlated with circulation in the normal person; also by a relatively higher threshold of flicker fusion vision, and by the larger diastolic surge of the brachial sphygmogram. Such gearing up of the circulation means, after adequate warm-up, that the small vessels (arterioles and some capillaries) dilate. Pulmonary vasodilatory nerves have been discovered (4, 25). Since many of the changes indicated above, attributable to physical training, can be induced by injections of adrenalin, thyroxin, and similarly acting substances, it seems reasonably certain that physical training induces relatively greater function of the corresponding glands of internal secretion (32, 36, 38, 39, 48).

The building up of various storage reserves (glycogen in the muscles, fat, hormone reserves in the glands) is a parasympathetically dominated series of functions (1, 2). The release of such reserves is a sympathetically dominated series of functions (1, 2). Repetitious physical training affects both.

In parasympathetic dominance the individual lapses into a relative state of rest and relatively greater gastric activity of digestion, or into feelings of comfort or relaxation. The sympathetically dominated individual is more ready for brief spells of action, more ready for combat or flight, and is, consequently, more active in all of his glandular "outflow." It should be obvious that high level sympathetic activity should be followed with rest. It does seem that the athlete is able to relax more completely than the ordinary man when he lapses into rest periods. Both soldiers and athletes are known to be able to go to sleep right on the ground or in a jolting car or truck after hard exertion. It is indicated that the trained individual has greater range of physiological behavior and adjusts more quickly and fully to exertion (see Figure I).

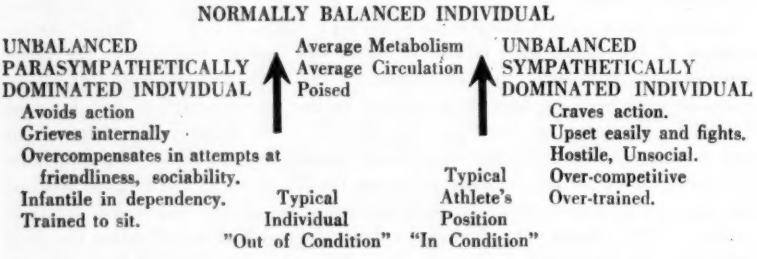

FIGURE I. Personality patterns associated with autonomic nervous states (from T. K. Cureton, "The Nature of Cardiovascular Condition," *Journal of the Association for Physical and Mental Rehabilitation* 11: 186-96; November-December 1957).

The Central Glandular Axis

With increased circulation associated with exercise or emotional excitement the entire central axis of glands is relatively more active. Exercise produces physiological reactions similar to anger (68). Such periods of emotional activity are conceived as necessary to healthy functioning, provided the exercise or emotional excitement is not overdone. The glands of the central axis are those which cluster along the spine from the top end (at the base of the brain) including (a) the pituitary, (b) the thyroid and parathyroid, (c) the suprarenals (adrenals), and (d) gonads (sex glands). There are also other glands in the body, such as: the pineal gland in the brain, the pancreas on the top side of the stomach, and the thymus gland which usually atrophies with the onset of puberty at about 13 to 15 years of age.

Aging and the Endocrine System

Old age is now viewed mainly as the time when the endocrine system fails to produce the hormones which are needed by the body. Science is now on the verge of being able to restore the needed hormonal balance but there is still much difficulty. Hormones normally considered protective become destructive if administered out of the exact proportion demanded. Hans Selye has championed the idea that heart trouble, high blood pressure, allergies, arthritis, rheumatic fever, certain skin diseases, and acute leukemia are linked directly to the diseases of "faulty adaptation" (59, 60). Cortisone (or a similar compound) is normally secreted by the outer layer of the adrenal cortex. ACTH is secreted by the pituitary gland. The ACTH travels through the blood stream to the suprarenals where it stimulates the adrenal cortex into producing more cortisone. Because stomach acids destroy ACTH rapidly, it must be injected. These hormones are not germ killers but are only biochemical agents without germicidal action. In disease or in severe burns the body fails to produce enough of these substances. It is better for the body to produce them normally, which is the hope of those who aim to do it by keeping fit.

The exact way cortisone and ACTH work is not known (28, 32, 44, 45). According to one theory they may have a "washing out" effect to remove the poisons which clog the surfaces of enzyme particles, which paralyzes their ability to break down tissue debris. This is the supposed action in arthritis and rheumatism. The hormones reduce the pain so that massage and exercises may be used. But many difficulties have appeared due to lack of exact prescriptive knowledge, such as unusual hair growths in undesirable places and increase in the rate of multiplication of tuberculosis germs. Other hormones sometimes work and sometimes do not work in treating hives, asthma, and hangovers. Phillip S. Hench and Edward C. Kendall, of the Mayo Clinic, point out that the ACTH and cortisone hormones do not affect the basic causes but provide a sort of asbestos protective suit for a period (68).

Hormonal Balance

Two powerful counteractive systems operate in the body. The sympatho-adrenal system acts to speed up the body processes, raises the blood sugar level, and depletes the glycogen storage. This system, which is utilized largely in exercise, is counteracted by the vago-insulin system (1, 2). The latter acts to slow down the body. The first is dominant in sympatheticotonia, the latter in parasympatheticotonia. In work or during strong anticipation of effort the balance is with strong sympathetic activity of the autonomic nerves of the thoracic region. During rest the sympathetic activity wanes and the parasympathetic outflow of the vagus and visceral autonomic nerves becomes dominant. The normal balance is in between. Beyond a doubt, the hormone systems are partially under the control of the autonomic nervous system.

An example is one given in Fulton (29) indicating the sensitivity of the respiratory system. The respiratory center is sensitive to CO_2 and O_2 tension and also to impulses reaching it through the afferent nerve channels from the vagus nerve. It is also influenced by the aortic and carotid sinus reflexes. When the vagi are cut the respirations become slower, irregular, and deeper in amplitude. Thus the afferent fibers in the vagi exert a tonic influence on respiration. But during emotional stress or exercise the sympathetic activity causes faster respiration. Individuals who exercise regularly may train themselves to higher and higher levels of sympathetic response and also to lower and lower levels during relaxation when the vagus dominance becomes more prominent than normal, characterized by a slow pulse rate. Respiration and pulse rate may, therefore, be used to a certain degree as indicators of balance of the autonomic nervous system, but the pulse wave is probably much better, the tall, sharp, and fast pulse being indicative of excitement, sympatheticotonia, and strong heart contractions and blood flow. Conversely, the flat pulse wave and slow pulse rate are indicative of parasympatheticotonia.

Fulton further points out that the smooth muscle of the bronchial tubes receives both sympathetic and parasympathetic innervation. Stimulation of the sympathetic system as in exercise produces dilatation of the bronchi tubules as an aid to breathing during hard exertion. During rest the parasympathetic fibers take over while the sympathetic stimuli subside, causing a tonic constriction of the bronchial musculature. If this constriction is great, as in certain states of asthma, there may be bronchial spasm, but this can be relieved in a dramatic manner by adrenalin or hard exercise. We have here an illustration of the antagonistic action of the two halves of the autonomic nervous system, which explains many of the differences between rest and exercise states.

A. Pituitary-Adrenal Glands

Effect of Exercise on the Pituitary Gland

Animal experimentation has shown that exercise could increase the weight of the pituitary glands in male rats by 10.25 percent, whereas hypophysectomy (surgical elimination of the pituitary body) produced an abrupt decrease of one-tenth of the physical activity of the rats along with marked loss of appetite and weight. Injections of pituitary extract failed to maintain normal growth and activity in the males. Removal of the anterior lobe of the pituitary produced extensive atrophy of the adrenal cortex and decreased work

capacity. The adrenal cortex secretion (cortin) had the effect of increasing work performance in rats with the pituitary body removed but did not affect normal rats. These series of experiments were done by Hatai, 1914 (32); Richter and Wislocki, 1930 (32); Ingle, 1936 (32); Richter and Eckert, 1937 (32); and Moon and Evans, 1938 (32).[2]

Effect of Exercise on the Suprarenal Glands

Treadmill running exercise affected the growth of the adrenal glands in dogs by 21 percent and in swimming dogs by 28 percent. In rats that ran on a treadmill to exhaustion there was an increase in lipid content in the inner fascicular zone and a slight increase in the glomerulosa and reticulata of the adrenals. In three-hour exercise periods the adrenals decreased in size and the lipid content was increased. Among rats with the adrenal glands removed there was a sharp diminution of the voluntary activity over a period of 7 weeks but after 16 weeks some of the rats recovered. In one work experiment the endurance of the adrenalectomized rats was only one-sixteenth that of the controls but their initial strength was not affected. In several experiments with normal rats cortical injections did not affect their work capacity, but in 1932 an experiment with dogs reported an increase of 100 percent in work capacity due to injections of cortical extract (32).

Increase in the weight of the adrenals of rats was just noticeable after six hours of work by the calf muscle, but after six more hours of work there was an appreciable increase. In adrenalectomized dogs the average blood sugar levels were reduced by 40 percent, the liver glycogen reduced by 85 percent, heart glycogen by 75 percent, and muscle glycogen by 45 percent, with very low basal metabolic rate (14, 15, 31). The evidence suggests that the adrenals secrete two substances, one which keeps the animals alive and one which keeps the animals normally active. Capacity for endurance, as well as the urge for activity, is mainly dependent upon adrenal function (42, 43).

It is not certain that cortin (now known to contain the active adrenal steroids) affects the circulation, metabolism, nervous state, and muscular condition. In experiments with dogs low blood sugar values in adrenalectomized animals were raised and lactic acid levels of the blood were lowered when hormone-containing extracts of the adrenal cortex were administered. Body temperature was reduced and pulse beats were increased. Many of these changes also occur in normal animals. When animals were exercised vigorously in swimming, the muscle and liver stores of sugar (glycogen) were depleted concurrently with augmentation of blood sugar (glucose) and blood lactate (lactic acid). Profound emotional excitement also causes similar depletion, but with injections of adrenal cortex hormone the blood glucose and liver and muscle glycogen values were considerably elevated within an hour after injection, which values remained high for over six hours (32).

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[2] These studies are reviewed in the article by C. W. Hackensmith.

Administration of cortico-adrenal extract saves from death animals which have had both pancreas and adrenals removed by surgery when such injections are given at the time blood sugar and temperature are lowest. It was concluded by Britton and Silvette, 1932 (14, 15, 32), that the adrenal cortex and its secreted hormones are mainly responsible for maintaining the normal levels of glucose in the blood and glycogen in the muscles and liver, so essential for vigorous athletic action or physical endurance.

Eagle and Britton, 1932 (32), found an increase of running endurance in dogs of 100 percent after administering cortin, but others have not got such increases from cortin. Procter and Best, 1932 (32), demonstrated that dogs exercised for several weeks showed a considerable increase in the glycogen content of the trained muscles. But in dogs given a much longer period of training, which greatly increased their endurance, this increase in glycogen disappeared, although the dogs still had greater endurance than they had before training. The assumption is that physical training improves the function of the adrenal glands for hard work, at least up to a certain point.

Evaluation of the 17-Ketosteroids of the Urine and Eosinophils of the Blood

Since the early experiments just described, there has been great interest in the evaluation of the 17-ketosteroids of the urine because of the belief that these indicate the extent of the adrenal cortex function. In 1944, the first important summary of this work appeared as written by Hudson Hoagland, director of the Worcester Foundation for Experimental Biology, Clark University, Worcester, Massachusetts. His summary paper is entitled "Adventures in Biological Engineering" (35). He concluded that the efficient man tended to conserve the hormone secretions and excretions; thus, after mild exercise in pursuit meter experiments by Pincus and Hoagland (50) lasting from two to six hours, the more efficient men showed little increase in 17-ketosteroids over their normal resting values, whereas the inefficient men who made relatively the greater number of errors had a larger output. The correlation between the 17-KS after stress and the performance was 0.723. The correlation between stress and the amount of urine secreted (diuresis) was 0.519.

The same types of increases occurred in doctoral students while they were taking a final doctoral examination for one to three hours. Also, it was found that the longer aviators stayed in the air the greater was the excretion of 17-ketosteroids in the urine, a correlation of 0.978 between the amount of 17-KS and the time they remained in the air. In all of this submaximal physical work the "best" was associated with the least excretion of 17-KS. This corresponds exactly to the quiet and submaximal type fitness tests in terms of pulse rate, blood pressure, and RQ (respiratory quotient in expired gas).

There is a normal tendency to maintain the homeostasis, to use a term coined by Harvard's Walter Cannon (17). In moderate exercise on the treadmill, the lower the oxygen cost, the more efficient the work. In hard exercise the situation is thought to be different. When there are more than three liters of oxygen deficiency (called "Oxygen Debt" by England's A. V. Hill), the subject will come to exhaustion because he cannot take in sufficient oxygen for his needs and the internal discomfort makes him stop the work. The output of KS in normal healthy men is 7 to 27 mg./24 hrs. urine sample and for women 5 to 16 mg./24 hrs., lowest in sleep and 60 percent higher after waking and in the first hour or two of the day, again returning to minimal levels at night. In hard exercise the excretion is supposed to be proportional to the activity of the adrenal cortex; then it may rise to 55 or over. Only a small part of the 17-KS secreted appears in the urine as excreted values. This makes the interpretation difficult for a given person because it is never known just what percentage of his total capacity is represented (35, 47).

In an experiment carried on in 1948 by Robert Melampy in the Physical Fitness Research Laboratory of the University of Illinois, the following results were obtained before and after hard "all-out" runs on the treadmill:

KETOSTEROID SECRETION COMPARISONS

(in mg./24 hrs.)

Subjects	*Basal Values*	*Before Running*	*After "All-Out" Run*
Kachiroubas (National AAU Wrestling Champion)	6.648	12.288	55.400
Karkow (Big-Ten 2-Mile Champion)	0.552	2.256	25.440
Fisher (Baseball Player and Skater)	3.864	6.360	16.560
Wasser (Indoor Shotput Champion)	6.240	12.096	15.336
Strydom (Normal Young Man)	1.665	2.208	12.408

These results suggest that the endurance-type athletes are able to excrete more 17-KS, probably indicating that they have stronger adrenal glands. In "all-out" efforts the total capacity is important rather than the "efficiency," the latter meaning their conservation over a long period of time. This is exactly the way oxygen-intake measures are interpreted. In an "all-out" effort the performer needs all of the oxygen that he can get, and his performance is mainly determined by the total amount he can get during the time of his run plus what he can use of that which has been in storage in his body (in reserve).

Eosinophil Counts as Indicators of the Functioning of the Adrenal Cortex

Due to the technical difficulties and great cost of the 17-ketosteroid work, an indirect method has attracted great attention, namely, the evaluation of the eosinophils (a type of white blood corpuscle, or leucocyte) in the blood.

The eosinophils are formed in the bone marrow. Under the microscope these cells appear orange in color when stained with orange-red eosin stain. They are reduced in number by emotional strain, severe homorrhage, burns, or severe exercise. This reduction in eosinophil count indicates that the adrenal cortex is functional. This has been explained by the adrenal medulla secreting epinephrine (adrenalin) and this affects the pituitary and other glands. The injection of cortisone (from the adrenal cortex of animals) also reduces the eosinophil count 50 to 85 percent (13, 54). It is also believed that anoxemia stimulates an increase in the activity of the cortex of the adrenal gland, and such reduction also occurs in extreme breath holding or in "all-out" endurance exercise. Such eosinophil reduction is considered a *normal* function. It has not been determined whether such reduction is correlated with the length of time a man can run on a treadmill or the time he can make in a race, but it probably is.

Albert E. Renold (54) determined that the normal count of a Harvard varsity crew averaged 123 when there was no stress. After a hard practice row the average count of this same crew dropped to 19. When the day of the Yale race came, the counts were down to an average of 64 before anyone had lifted an oar. After a grueling race of four miles, the eosinophils averaged 3 for both oarsmen and coxsawin. The coach's (Tom Bolles) eosinophil count dropped from 101 before to 6 after the race.

A drop in the eosinophil count may indicate nervous tension. The count will go up after relaxation is achieved. Extreme drops in the count may parallel exhaustion. Thorn (64, 65) has reported it was his belief that if an exhausted man failed to drop his eosinophil count while becoming exhausted, this can be taken as a sign that the adrenal cortex did not produce the extra hormones which the body demanded under stress. Such a condition would probably be associated with a poor performance.

In certain hospitals a test is now available for indicating whether the adrenal-pituitary axis is functional. It is known as the Thorn Test (64, 65). If under ACTH administration the eosinophils fail to fall, the indication is that the adrenal cortex is nonfunctional. If the count rises, there is a suggestion of malfunction of the adrenal-pituitary hormone balance. Extreme hypo-function of the adrenal cortex is called Addison's disease. Recently, the eosinophil count has been used to indicate various forms of stress due to infection, emotional upset, and other derangements. Doctors complain that it is a nonspecific indicator of some form of stress, but all too frequently the cause is not easily traceable.

An example of eosinophil counts would help to illustrate this point. In

the work of Kellgren (38) the following data show the effect of administering 25 mg. of ACTH. Normal reaction is supposed to be indicated by a drop of 50 to 100 percent:

	Eosinophil Counts[3]	*Percent Fall*
Normal Subject 1	276 to 7	97
Normal Subject 6	362 to 7	98
Normal Subject 5	400 to 144	64
Normal Subject 3	318 to 137	57
Sick Patient 1	59 to 22	62
Sick Patient 2	200 to 25	87

Then we might compare a few subjects tested at the Urbana Laboratory (Physical Fitness Research Laboratory, College of Physical Education):

Subject W. H. (champion swimmer out of condition)	Fatigue Indicated	67 to 44	33
(same swimmer after month of training)		44 to 22	50
Subject C. C. (good college runner out of condition)	Fatigue Indicated	421 to 233	45
(same runner after month of training)		89 to 22	75

B. Basal Metabolism and the Thyroid Gland

Animal Experiments on the Thyroid Gland

Several experiments show a marked drop in spontaneous physical activity (treadmill running) of thyroidectomized rats, but with thyroxin therapy they were restored to normal simultaneously with a raising of the metabolic rate. The thyroid gland is heavier in animals exercised with endurance activity. Steinhaus, Hoyt, and Rice (32), in 1932, found a 10 percent increase in dogs due to running and a 34 percent increase due to swimming. Feeding desiccated thyroid did not produce an increase in activity until other glands appeared to compensate in one to two months' time. If thyroid activity is already normal, activity will not usually increase it, but if it is low in a sedentary person and activity is begun on a persistent and progressive basis, the basal metabolic rate will rise from 5 to 30 percent over a period of several months. Since this is a very important observation made in several years of investigation in the Urbana Laboratory, it will bear some elaboration.

In the first place, the rise in basal metabolic rate is logical. It is highly correlated with circulatory rate (3, 8). Exercise certainly improves the circulatory rate if the exercise is persistent enough over several months and is hard enough in the endurance sense. It is endurance exercise which improves the circulatory rate, and, also, it is hard rather than easy exercise. We have observed that weight will be reduced by our type of physical exer-

[3] The average number of cells in a counting chamber (Neubauer haemocytometer) is multiplied by 11.1 and the four chambers added for the total. The average of quiet non-exercised subjects is about 300, the range from 29 to 564.

cise programs run over several months with emphasis on endurance and "test exercises." Time and again appreciable weight has been lost from men who are overly heavy to begin with, and the fat loss has been measured in many of these with adipose tissue calipers.

The usual report is that not much change occurs in the first month or two while the exercises are easy and the man is gradually working into the program, holding back trying to make an adjustment. One man at a weight of 193 lbs. began to run five days per week on the track, running two miles per day. For two months he stayed about the same within a pound or two. Then he began to run harder, mixing in more "pick-ups" after a two-mile preliminary run. His weight in the next three months came down to 168.

A comparison was made between young college men classed as athletes and those classed as nonathletes. Leilich (40) found the athletes to average 7 percent higher in basal metabolic rate. This may be because athletes have more muscular tissue than fat, and we know that muscle consumes more oxygen than fat on a minute-after-minute or hour-after-hour basis. Bender (6) investigated this as a doctoral problem and found that every one of his below normal subjects improved the basal metabolic rate in a program of hard endurance training lasting several months. He attributed the gains to increase of lean muscle tissue and reduction of fat, leaving the body with a relatively higher proportion of lean muscle tissue to other types of tissue. Two of Bender's other subjects did not improve but these were normal at the start of the experiment. In this work, each man was tested six times at each stage of the experiment. The work was done in an atmospherically controlled laboratory, from 7 to 8 a.m. before any noise or confusion developed in the building. Mayer and Stare (44) have also presented data to support the view that exercise may increase metabolism and reduce cholesterol.

In 1950 Lorraine Neilson (49) investigated 24 college girls who were low in basal metabolic rate. She made the initial tests before the girls were enrolled in a swimming course lasting four and a half months at the University of Illinois. After the swimming course 20 of these girls had improved their basal metabolic rate. Two of the others gave up the course because of illness. Two of those who did not improve were found to be on reduced carbohydrate diets and had more absences than any of the other girls. For those who improved the basal metabolic rate, the average gain was about 10 percent.

A review of the literature on this problem shows considerable disagreement (23, 66). Few of the experiments have been well controlled. It is recognized that the basal metabolic rate will reduce in a series of trials, usually indicating mental adjustment to the test with less and less muscular tension during the period of breathing the oxygen. In several experiments the nature of the exercise involved has not been described (66). In others the weather conditions were not comparable at the start and at the finish of the experiments.

In explaining the meaning of a rise in basal metabolism with physical training, it is reasonable that any depletion of the carbohydrate reserves (glycogen deposits) in the tissues might cause a drop in basal metabolic rate (7). Since glycogen deposition increases with most types of exercise programs, we would expect a rise in basal metabolic rate (6, 52). It has been shown that basal metabolic rate reduces in starvation experiments (47, 49, 66). Exercise usually builds up the firm part of the muscle and reduces the fat. This would seemingly increase the need for oxygen, since muscle uses more oxygen than fat. Depletion of the glycogen stores would also explain why a few endurance runners, tested the day after a hard race, show reduced basal metabolic rate and also lower T and R waves of the ECG. We have also observed that pulse rates and pulse pressures drop during hard training. Since the basal metabolic rate is fairly well predictable from the Read equation (53)

$$\text{BMR} = 0.39\ (\text{pulse pressure}) + 0.52\ (\text{pulse rate}),$$

it might be expected that basal metabolic rate would go down if the work were hard enough to reduce the pulse pressure or the pulse rate. Very hard exercise may reduce the BMR temporarily. We have found that rest for two days before a BMR test will raise the BMR somewhat over what it would have been had hard exercise been taken on the two days before the test.

We believe that increased basal metabolic rate usually means improved circulatory rate, if and when it is observed in association with improved cardiovascular condition tests. The matter is very much an individualized one, depending upon how an individual is adjusting to exercise. Some individuals may work too hard to improve the BMR, whereas others may work too little. In general, the individual with low metabolic rate, who tends to be overweight, can reasonably expect a 10 to 15 percent improvement in BMR in a gradually built-up exercise program over five or six months. This illustrates the effect of exercise to normalize a person. There is evidence now that persistent physical training over several weeks or months will lower the serum cholesterol and this is paralleled by a rise in basal metabolism (5, 30, 51).

C. Pancreas and Diabetic Conditions

Effects of Exercise on the Pancreas

Several studies have shown that exercise helps the pancreas produce more insulin or affects the need or utilization of insulin in some way so that less and less of it is needed. Joel E. Goldthwait (31) experimented with this problem for a number of years and published several papers advocating exercise for diabetic patients. His main contention was that poor posture, characterized by droop of the head forward, caused a V-shaped ligament, known as the suspensory ligament just above the pancreas, to pinch off the supply of blood to the pancreas, thus causing interference with its ability to

produce insulin and other digestive juices. In experimenting with patients who could not maintain normal blood sugar without insulin he found that exercises which emphasized better head and chest posture, along with better breathing, brought about marked improvement. This led to reducing the amount of insulin needed.

George Deaver (26) has reviewed the literature of this problem and points out that exercise is usually very helpful to the person with diabetic tendencies. In some way it helps to utilize the blood sugar better, and it probably helps the pancreas to function in a normal way by improving circulation to this gland. It has long been known that exercise improves the utilization of carbohydrate food (61).

D. Gonads

Animal Experimentation on the Gonads

The function of the ovaries and testes is dependent upon the secretion of the pituitary gland, since without it these glands become inactive and atrophy In exercised animals the gonads in male rats increased 12.33 percent in weight over the controls. Castration of male rats decreased their voluntary physical activity 60 percent. After removing the ovaries from female rats their activity was decreased 90-95 percent. The strength per gram of muscle showed a 40-percent loss for castrated male rats over the controls in female rats but no difference in male control rats. Follicular injections raised the activity to normal level in female rats. These experiments were reported by Hatai (1914), Rice and Steinhaus (1929), Hoskins (1925), Durrant (1924 and 1927), Gans and Miley (1927), Wang and others (1928).[4]

Sexual Function Related to Exercise

The experiments on animals seem to indicate that physical activity would affect the physical fitness and also the sexual response of humans. This is not a fully explored subject. If Kinsey had asked more questions related to the exercise habits of the various men and women whom he interviewed, we might know more of the trends of this relationship. He only showed that sexual response was more frequent among workers than among relatively sedentary intellectuals. The sex act is an act requiring some physical exertion. It sometimes requires too much energy for some people to perform it. Unfit people are quickly exhausted, whereas the interest and ability of well-conditioned people is rather well known, especially workmen. Considerable incompatibility may result from one partner being unfit while the other is fit, full of abundant energy, and relatively unfatigued by daily practice (34, 41).

One of the reasons for participation given by some individuals in our own program of physical fitness for middle-aged men and women is their feeling of fatigue or even inability connected with the normal sex functions. Age seems to have less to do with their relative status than their physical fitness,

[4] Refer to Hackensmith (32) for all these references to animal experiments.

feeling of well-being, warmth, and general state of energy. In the data on older men and in testimonies given by them, there is an excellent association between abundant sexual energy and the state of physical fitness. Some of the subjects over 50 years of age with low muscular strength and muscular endurance report considerable or even total loss of the climax function. There is considerable difference in the comparisons between the 20- and 30-year age span for frequency of participation compared to the 40- to 60-year age group. Because people are "just supposed to age," some of this reduction is to be expected. Nevertheless, it is a reflection of declining energy, lowered circulatory, metabolic, and muscular fitness, and a decline of the glandular functions. Anyone interested in this parallelism should compare the curves from plotting Kinsey's reported incidence of "orgasm" figures with the curves of declining physical fitness. There is probably a remarkable agreement. Common sense indicates a causal connection, but exact experimental procedures are virtually impossible at the human level. Practically none is so far reported.

The fact that the physical fitness measures can be reversed after 40, 50, or even 60 years would seem to reflect some trend toward restoration of normal youthful functions, including the sex function. This is supported by occasional voluntary testimony by men who have reported renewed warmth of well-being and some noticeable pick-up of sexual interest and participation. This comes after several months of physical conditioning. There is a strong association between the physical fitness level and the capacity for sexual orgasm. In males, the onset of the climacteric can be minimized in its effects, usually reported to be accompanied by enlarged prostate gland, diminished sexual energy, instability of the nervous system, partial or complete impotence, and tendencies for pains to appear (usually called rheumatic) in the limbs and lower back.

E. W. Hirsch, according to Henderson (34), reports that the unevacuated prostatic fluid becomes toxic. The male organ is also reported to deteriorate if not used in regular function. It is certainly no longer believed that mental or physical deterioration is associated with abundant use of the sexual function. Moderation is probably an important rule for those in moderate levels of fitness. Others should be guided by their levels of fitness and by their feelings. Freud's material states that the sexually unsatisfied adult usually develops anxiety and various aspects of disturbed personality (69).

The present concept is that reasonably full use of the sexual function in the normal and accepted social way is highly associated with the normal integrated personality. The concept of the wholesome personality is associated with abundant energy, extroverted personality, and courage for living vigorously. Alexander (1) states: "Sexual maturity is gratification of sexual need without straining the conscience."

The same effects of anxiety, worry, intense mental concentration, mental depression, and loss of sleep which result in depletion of the nervous energy and lowering of the cardiovascular condition also cause loss of sexual libido

and response (62, 67). In due time, such unfitness leads to impotence. Exercise is important to keep the nervous system normal. Exercises and baths which improve the circulation and the nervous state, if not too severe and exhausting, will improve the condition for normal sexual expression (3). It is possible that the most important influence will be traced to the relaxing effects of exercise and baths, which relieve inner-psychic conflicts. Sedentary living, tense mental work, disappointments and frustrations, obesity, and poor tolerance of exertion all go with lowered ability and interest in sexual participation. Men are usually very frank about this in their personal interviews concerning fitness problems (21).

The more obstinate cases of sexual difficulty belong, of course, to the psychiatrist or medical doctor. The exercise program is mainly preventive or corrective for beginning trends of weakness. Reported in the sex literature are the many perverted tendencies of individuals seeking stimulation by such dangerous procedures such as use of alcohol, strychnine, phosphorus drugs, red pepper, yohimbine, cantharides (Spanish fly), or narcotics. The healthy approach is to ban these completely and depend upon the normal build-up of the body and its physiological systems by good hygienic living.

Good foods are a normal part of the process. In semi-starvation people lose their sexual libido and capacity. The latter is supposed to be augmented by eating more sea foods, baked, broiled or raw (oysters, clams, shellfish); natural phosphorus containing grains (oats, whole bran, whole rye, whole barley, whole wheat); protein foods (cheese, lentils, beans, peas, nuts, lean meats); green and red and yellow vegetables (some raw); tops of greens, parsley, chopped fresh cabbage, lettuce, berries, carrots, and radishes. Positive research on this aspect is lacking, but such foods do aid fitness in general (34).

Effects of Exercise on Genitalia

Exercising the perineal region stimulates the circulation in this area. A number of exercises have this effect other than direct massage, such as: rhythmic tightening of the buttocks, side leg-raisings (lying on the side with rapid raising and lowering of the top leg for several minutes on each side), flutter kicks on the front, and all exercises which involve alternation of intra-abdominal pressures, deep breathing followed by breath holding, alternate contraction and retraction of the abdominal muscles, repeatedly bending the trunk forward and downward while sitting, and flutter kicks or leg raisings on the back while lying on the back. These are all effective means of massage brought about by increasing and relaxing the pressures. Similar effects are brought about by alternation of hot and cold water baths (34, 41).

Medical Treatment Important

It is dangerous to delay seeing a competent urologist in the face of severe pain, bleeding in an abnormal manner, or badly restricted function of urination. There may be danger of cancer. While good hygiene may be

helpful in general, more drastic treatment may be indicated. With mildly restricted urination the exercise of rhythmic tensing and contracting the bulbocavernosus and external sphincter muscles while urinating may be helpful.

In extremely obstinate cases of sexual frigidity or impotence, a medically prescribed hormone prescription may be tried, strictly under a physician's orders. Usually, the services of an expert gynocologist or endocrinologist should be sought. The exact proportions of male and female sex hormones for optimum effect for each individual are not known.

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Analysis of Fundamentals of Fencing[1]

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Abstract

The purpose of the study was (a) to analyze the fundamentals of fencing as performed in accordance with the classical forms; (b) to compare the data in *a* with the data obtained when these fundamentals were performed in accordance with nine variations of the classical forms; and (c) upon the basis of the comparisons in *b*, to suggest deviations from the classical forms which might result in improved techniques. The evidence presented in this study indicates that performances from each of five variations from the classical on-guard are, for certain fundamentals of fencing, superior to performances from the classical on-guard.

DURING THE PAST four centuries fencing has evolved from practice for mortal combat to one of the most refined of combative sports. Early in the history of fencing, instruction became rigid and classical forms were established. The implements and conventions of fencing, however, continued to change. Consequently, modern fencing provides for faster performance than did fighting with the sword, yet modern instruction in the performance of the fundamentals is similar to the instruction of about three and a half centuries ago. Since the classical forms were pragmatically derived, the objective measurement of such factors as time, linear displacement, velocity, accuracy, and balance, as these factors are related to the fundamentals, would be expected to provide data by means of which fencing techniques could be improved.

The purpose of the study was (a) to analyze, in terms of time, linear displacement, velocity, accuracy, force, and balance, the fundamentals of fencing as performed in accordance with the classical forms; (b) to compare the data in *a* with the data obtained when these fundamentals were performed in accordance with nine variations of the classical forms; and (c) upon the basis of the comparisons in *b*, to suggest deviations from the classical forms which might result in improved techniques.

The fundamentals considered in this study are the on-guard, the advance, the retreat, the lunge, the recovery rearward from the lunge, the advance-lunge, the retreat-lunge, and the flèche. The classical forms for executing these fundamentals and nine variations of the classical forms were analyzed and compared.

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[1] This report is a synopsis of a study that was made in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Division of Physical Education in the Graduate College of the State University of Iowa, Iowa City, 1958, under the direction of Louis E. Alley. Full details may be obtained from the original source.

Procedure for Obtaining Data

Subjects. Four subjects, all considered expert fencers, were used in this study. Subject A had 13 years of fencing experience; Subject B, 2 years; and Subjects C and D, 3 years. Subject A was an international competitor who had won fencing competitions in the United States and abroad. Subjects B, C, and D were selected from the State University of Iowa fencing team.

Equipment. A 16mm camera was used to take motion pictures of European fencing champions[2] and of Subject A. A wink-counter (4) was used as a timing device for the motion pictures taken of Subject A. The Fencing Recorder was used to gather data on the fundamentals of fencing as performed from various starting positions by Subjects A, B, C, and D.

The Fencing Recorder (see Figure 1) consisted of four parts: platform, target, foil, and recorder. The recorder was connected by a conductor cable to the platform and to the foil. A system of relay circuits and capillary pens was activated by actions of the fencer (a) at the instant the point of the foil struck the target with a minimal force of 750 grams; (b) at the instant the foil-arm moved forward; (c) at the instant the foil-arm decelerated; (d) at the instant that rearward horizontal thrust in excess of 40 lbs. was applied to the rear footplate; (e) at the instant that rearward horizontal thrust applied to the rear footplate was reduced to 35 lbs.; and (f) at the instant that contact was made or broken with the switchmats. A synchronous motor provided a .1-sec. time line. This apparatus is described in detail elsewhere by the writer (3).

Phases of the Study. Phase I.—Motion pictures of European champion fencers in action were carefully examined, and the on-guards utilized by the fencers were analyzed and compared. Comparisons were also made between the fundamentals executed by the champion fencers and the classical forms for those fundamentals. Phase I was undertaken in an attempt to select for further analysis plausible variations of the classical forms.

Phase II.—A cinematographic analysis of the fundamentals of fencing as performed by Subject A was made. This analysis was used as an aid in the selection of the nine variations of the classical on-guard, as an aid in the interpretation (in terms of movement patterns) of the data subsequently collected by means of the Fencing Recorder, and as an aid in the formulation of deviations from the classical forms.

Phase III.—A time analysis of the fundamentals of fencing as performed by Subjects A, B, C, and D was made by means of the Fencing Recorder. In this analysis the movement patterns of Subjects A, B, C, and D were compared to determine whether or not the movement patterns of Subject A differed from the movement patterns of Subjects B, C, and D. Since the

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[2]Motion pictures that the writer took of (a) the Coupa Gaudini, Rome, Italy, 1952; (b) the Coupa Gaudini, Paris, France, 1953; and (c) the World Fencing Championships, Brussels, Belgium, 1953.

movement patterns did not differ significantly, extensive data were collected on Subject A.

Phase IV.—A detailed analysis of the fundamentals as performed by Subject A from the classical on-guard and from nine variations of that position was made by means of the Fencing Recorder.

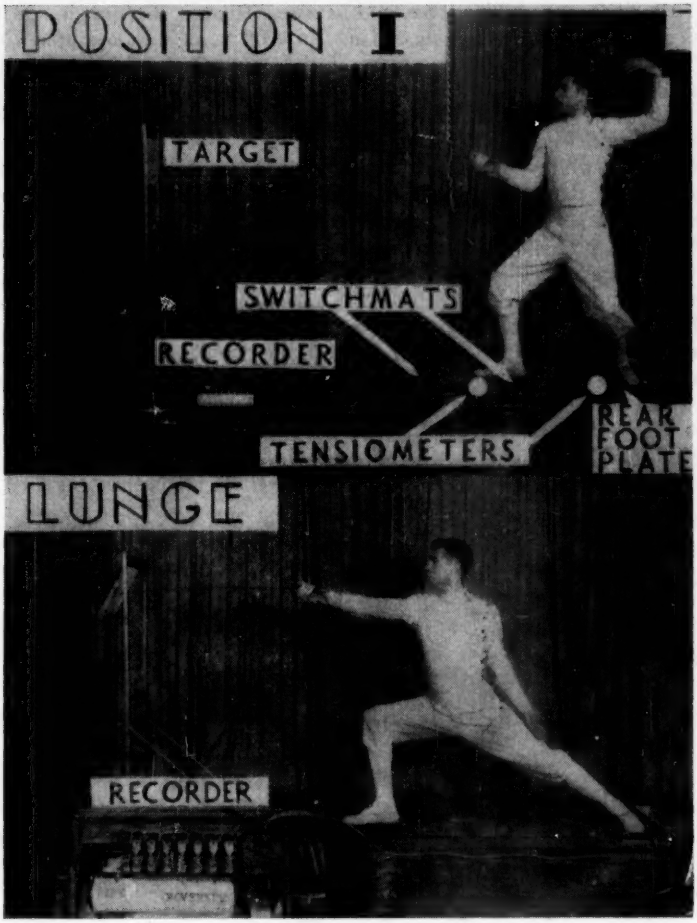

FIGURE I. The fencing recorder. Measurements were recorded for the advance, the retreat, the lunge, the recovery from the lunge, the advance-lunge, the retreat-lunge, and the fleche as performed from Position I, shown at top.

Fencing Forms for Which Measurements Were Recorded

Measurements Recorded. Measurements were recorded for the advance, the retreat, the lunge, the recovery from the lunge, the advance-lunge, the retreat-lunge, and the flèche when these movements were performed by Subject A from the classical on-guard (Position I) and from each of nine variations from the classical on-guard (see Figure II).

The measurements recorded were time, horizontal displacement, accuracy (if striking was involved), force, and balance. Time, in .01 sec., was measured from the recorder tracings. Time, in .002 min., was measured from the wink-counter. The displacement of the omphalion was traced in the vertical, horizontal, and lateral planes from motion pictures of Subject A as he performed the fundamentals of fencing. Horizontal displacements were measured to the nearest .1 in. Accuracy of the touches was measured from paper targets with 5-point scales. Force, in tensiometer scores, was converted into pounds. Balance was judged by the subject's ability to remain in a stable position at the end of the movement.

Statistical Procedure. The assumption was made that the five trials of a particular movement performed from a particular position represented a random sample of such trials and that variations in such trials were normally distributed. Upon this basic premise, and upon the added assumption that each mean could be more or less variable than every other mean, the sets of scores obtained for the various trials were tested by the Bartlett test for equal variability. If equal variability could be assumed, then the sets of scores were tested for equality of means by a simple analysis of variance. If equal variability could not be assumed, then Lindquist's recommendation (2) was followed: namely, the 2.5 percent level of significance was used in

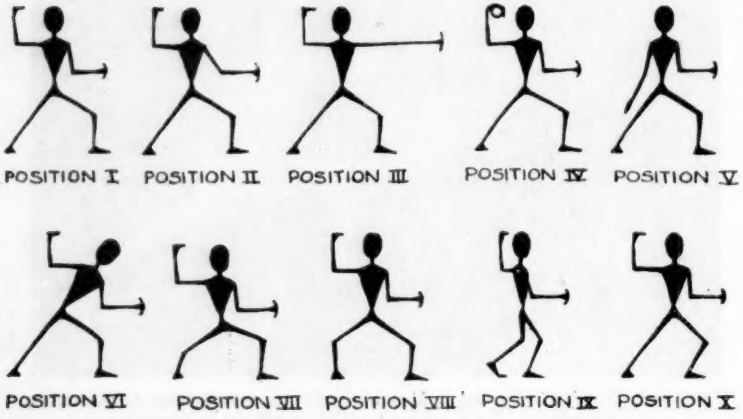

FIGURE II. The classical on-guard (Position I) and nine variations.

the ensuing simple analysis of variance in order to obtain a 5 percent level of significance control over the Type I error. If the analysis of variance yielded an unusual F, then specific differences were tested. Throughout Phase IV of the study, a 5 percent level of significance control over the Type I error was chosen for all the statistical tests used.

Reliability

Reliability of Performance. Performances of the lunge from three variations of the classical on-guard were arbitrarily chosen as representative movements, and the data recorded for these movements were subjected to an analysis for reliability. The reliability of Subject A's performance was, on nine tests administered on five consecutive days, determined by the analysis of variance technique described by Ebel (1). The r of reliability of a single trial from the first position tested is .33, and the r of reliability of the mean of five trials is .72. The r's for the second and third positions are, for the single trial, .46 and .35, respectively; and for the mean of five trials, .81 and .73, respectively.

Reliability of Measurement of Fencing Recorder Tracings. The r of reliability of the measurement for ten tracings, as determined by Ebel's analysis of variance technique, is .9920 for pens making contact with the kymograph and .9935 for pens breaking contact with the kymograph.

Analysis of Phase IV[3]

Advance. Executing the advance from Position I, the subject first lifts and then displaces forward the forward foot. Within .02 sec. the rear foot develops 40 lbs. of thrust horizontally rearward, and within .32 sec. the rear foot attains a maximum thrust of 70 lbs. Within .19 sec. after the initial movement of the forward foot, or .17 sec. after the development of the 40 lbs. of thrust, the subject is accelerating sufficiently to activate the mercury switch in the foil. This acceleration lasts for .10 sec. While the subject is thrusting with the rear foot and accelerating, the forward foot lights. The flight time for the forward foot is .25 sec. The rear foot then moves forward; acceleration ceases to be recorded; and then the rear foot lights, which movement completes the advance. In advances from Positions VII, IX, and X the subject has a tendency to start the movement by thrusting with the rear foot (see Table 1).

The results of the statistical analysis of the mean times required to perform the advance are summarized in Table 2. The mean times for the advances performed from Positions VI and X are significantly smaller than the mean time for the advance from Position IV. The mean time for the advance performed from Position IX is significantly less than the mean times for the advances from Positions I, III, IV, and V. The mean time for the advance performed from Position VII is significantly less than the mean

[3] The data and the analysis of the data for Phases I, II, and III of the study are presented in detail elsewhere by the writer (3).

times for the advances performed from all the other positions except Position IX.

For the advance, analyses were also made for the velocity of the trunk, the velocity of the rear foot, and the flight times of the forward foot.

Retreat, Lunge, Recovery from the Lunge, Advance-lunge, Retreat-lunge, and Flèche. For the retreat, analyses were made for the time, the velocity of

TABLE 1.—ADVANCE PERFORMED FROM POSITIONS I TO X: MEANS FOR TIME, DISTANCE, VELOCITY, AND FORCE

Items	Positions									
	I	II	III	IV	V	VI	VII	VIII	IX	X
Time (hundredths of sec.)										
From start to thrust of rear foot	1.4	3.0	.4	1.2	1.0	.8	0.2	1.8	0.0	.4
From start to acceleration	18.0	22.0	30.5	18.2	16.8	20.0	16.2	17.2	23.0	27.8
From thrust of rear foot to acceleration	16.8	19.2	29.0	17.0	15.8	19.0	16.0	15.6	23.0	27.4
Thrust of rear foot	32.4	28.4	30.2	31.0	31.0	28.4	26.2	27.6	23.2	30.2
Acceleration	9.8	10.2	4.0	10.4	11.4	7.8	14.4	15.0	6.6	7.4
Flight of forward foot	24.6	24.4	26.2	24.4	22.8	21.8	19.0	27.4	23.6	27.0
Flight of rear foot	22.2	21.6	23.0	21.8	21.4	22.2	19.0	22.4	25.6	21.2
Advance	55.4	52.6	53.8	56.0	53.6	51.8	45.4	52.0	48.8	51.8
Distance (in.)										
Displacement of rear foot	17.8	15.7	17.1	16.5	17.2	15.8	16.5	16.5	15.4	14.8
Displacement of trunk	15.2	13.6	14.5	14.2	15.0	11.3	14.2	15.5	16.7	16.3
Velocity (ft./sec.)										
Rear foot	6.72	6.10	6.25	6.29	6.78	6.02	7.29	6.21	5.01	5.85
Trunk	2.29	2.15	2.25	2.21	2.33	1.83	2.61	2.48	2.86	2.62
Force (lb.)										
Thrust of rear foot	70.0	73.7	73.3	72.7	76.7	88.7	67.0	65.8	58.7	57.2
Thrust to stop	56.7	48.5	42.3	38.8	46.0	38.1	41.9	48.0	34.9	50.9

TABLE 2.—ADVANCE EXECUTED FROM POSITIONS I TO X: STATISTICAL SIGNIFICANCE OF MEAN DIFFERENCES OF TIME (HUNDREDTHS OF SECOND) REQUIRED TO COMPLETE MOVEMENT (ROW MINUS COLUMN)

Positions	I	III	V	II	VIII	VI	X	IX	VII
IV	0.6	2.2	2.4	3.4	4.0	4.2[a]	4.2[a]	7.2[a]	10.6[a]
I		1.6	1.8	2.8	3.4	3.6	3.6	6.6[a]	10.0[a]
III			0.2	1.2	1.8	2.0	2.0	5.0[a]	8.4[a]
V				1.0	1.6	1.8	1.8	4.8[a]	8.2[a]
II					0.6	0.8	0.8	3.8	7.2[a]
VIII						0.2	0.2	3.2	6.6[a]
VI							0.0	3.0	6.4[a]
X								3.0	6.4[a]
IX									3.4

[a]Significant at 5 percent level of confidence.

the trunk, the velocity of the forward foot, and the flight times of the rear foot. Analyses were also made for the time of the lunge, the recovery from the lunge, the advance-lunge, the retreat-lunge, and the flèche (3).

Findings

The European champion fencers during competition perform from on-guards that differ markedly from the classical on-guard. The movement sequences of Subjects A, B, C, and D during the performance of the fundamentals of fencing are alike in all respects except that Subject B lifts his forward foot before thrusting with the rear foot to start the advance-lunge. For the advance, the lunge, the recovery from the lunge, the advance-lunge, and the retreat-lunge, performances from Position VII are significantly superior to performances from the classical on-guard, Position I. For the advance, the lunge, the recovery from the lunge, and the advance-lunge, performances from Position IX are significantly superior to performances from the classical on-guard. For the lunge, the recovery from the lunge, and the advance-lunge, performances from Position VI are significantly superior to performances from the classical on-guard. For the recovery from the lunge, and the advance-lunge, performances from Position II are significantly superior to performances from the classical on-guard. For the recovery from the lunge, and the retreat-lunge, performances from Position III are significantly superior to performances from the classical on-guard. For none of the fundamentals of fencing are performances from the classical on-guard significantly superior to performances from Positions II, III, VI, VII, or IX.

Generalization

The evidence presented in this study indicates that performances from each of five variations from the classical on-guard are, for certain fundamentals of fencing, superior to performances from the classical on-guard. In addition, the purpose of the on-guard is fulfilled best from Position VII, which position is the classical on-guard modified by deep lower limb flexion.

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Energy Cost of Pull-Ups and Push-Ups as Related to Arm Strength Formulas

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Abstract

Using 35 students from the required physical education program, a comparison of the validity of the Rogers and McCloy arm strength formulas was made. The energy cost for the pull-ups and push-ups was used as the criterion measure. Findings revealed: (1) energy cost of the activity was not significantly related to bicep girth or total number of pull-ups plus push-ups, and (2) using energy cost as the criterion measure, McCloy's arm strength formula was slightly more discriminating than the Rogers formula for prediction of arm strength. However, because of the low correlations neither of the formulas could be employed to any significant extent as a predictive measure.

THE STRENGTH OF the arms is important for the successful execution of many motor activities. McCloy (5, 6) has conducted and reported a number of research studies illustrating the apparent importance of arm strength in activity. He compared the relation of arm strength and a composite score of back strength, leg strength, and arm strength to several other measures used as predictors. He found a correlation of .808 between force employed in the Sargent jump and arm strength. He also found that arm strength, as measured by chins, dips, and grips plus weight, correlated .542 with a criterion composed of six track and field events. Using a composite score composed of back strength, arm strength, and leg strength added to chins, dips, and grips plus weight increased the multiple correlation to .5528, which was only slightly higher than the correlation of arm strength plus weight.

Employing the composite strength score which included arm strength, McCloy correlated this with the variables of a track and field battery, football ability, and a subjective physical education classification. The results showed that the track and field battery correlated .9142 with the composite strength score, while a multiple of .9106 was obtained when just arm strength plus weight was used. In a similar manner, multiple R's of .5467 for the composite strength score and .4762 for arm strength plus weight were obtained, employing football ability as the dependent variable. When using the physical education classification in which students were subjectively ranked by instructors, McCloy found an R of .8842 with the composite strength score and an R of .8750 when only arm strength plus weight were included.

From these results, it may be concluded that back and leg strength seem to add little information to that given by arm strength plus weight in the prediction of general motor ability.

Presently two formulas, McCloy's and Rogers', are used to a considerable extent in appraising arm strength. Both formulas employ the number of pull-

ups on a chinning bar and the total number of dips performed on the parallel bars. These formulas may be written as follows:

Rogers (7) Arm Strength Formula:

$$\text{Arm Strength} = (\text{Chins} + \text{Dips})\left(\frac{\text{Weight}}{10} + \text{Height} - 60\right)$$

McCloy (5) Arm Strength Formula:

$$\text{Arm Strength} = 1.77 \times \text{Weight} + 3.42\ (\text{Chins or Dips}) - 46.$$

A discrepancy sometimes occurs when applying the two formulas to the same data. For example, the arm strength of an individual might be ranked high with McCloy's formula whereas the same individual could be classified low using the other formula. Because of this factor it might be contended that when one is measuring arm strength in terms of pull-ups and push-ups, a work criterion might be employed as one means of studying the validity of the formulas. Hence the fundamental assumption underlying this study contends that, if one expects to predict arm strength from a formula, a valid criterion of this formula would be the actual work done in executing the pull-ups and push-ups. The work done is measured in cubic centimeters of oxygen consumed and may be reported as such, or in terms of calories or foot pounds of work, whichever seems more appropriate.

The purpose of this study was to compare the validity of the Rogers and McCloy Arm Strength Formulas using energy cost of the pull-ups and push-ups as the criterion measure.

Method

Thirty-five male students from the nonmajor required physical education program at the State College of Washington were used as subjects. The only requirement was the subjects' willingness and ability to do several pull-ups and push-ups. The group had a median age of 19.5 with a range of 18 to 21 years. The median weight was 162 lb. and ranged from 132 to 201 lb.

Variables Studied

Anthropometric Measures. Three anthropometric measurements were taken: (1) weight, recorded to the nearest one-half pound with heavy clothing and shoes removed; (2) height, measured in stocking feet to the nearest one-half inch; and (3) girth of the tensed upper arm in the flexed position. The measurement was taken with a Gulick tape while the subject stood on the floor with the hand open touching the fingertips to the acromion of the scapula while contracting the biceps to form as large a circumference as possible. Both right and left biceps were measured.

Arm Strength. Pull-ups and push-ups were used to determine the strength of the arms and shoulder girdle. The pull-ups were performed on a 1-in. bar, 8½ ft. from the floor. Push-ups were executed on a wall parallel bar,

1¾ in. in diameter, 18 in. apart and 5 ft. 4 in. from the floor. The method of administering both pull-ups and push-ups was as described by Clarke (1).

Energy Cost of the Activity. Energy cost, as used in this study, refers to the amount of oxygen consumed by the individual while performing the push-ups and pull-ups over and above the amount used in a resting (sitting) position. The energy cost was measured with a closed circuit gasometer of the Tissot type having a capacity of 120 lit. The apparatus was equipped with a kymograph which permits one to measure the oxygen consumption while at the same time recording the time elapsed. The fundamental procedures in determining oxygen consumption described by Karpovich were followed (3).

Procedure

Following the height and weight measurements, the girths of the tensed, flexed upper arms were measured. The subjects were then seated in a rolling chair directly in front of the chinning bar, at which time the pull-up test was demonstrated and explained. The subject was then connected to the gasometer and given a chance to become accustomed to the instrument. From a sitting position, the subject at a given command began to perform the pull-ups. The hose connecting the gasometer to the mouthpiece was supported by a specially constructed boom.

Upon completion of performing the pull-ups to exhaustion, the subject was again seated in the rolling chair and remained connected to the gasometer until he returned to the respiratory pattern established in the preliminary five-minute resting period. It took about 15 minutes for the subjects to return to their resting rate following the pull-up exercise.

A ten-minute period of rest and relaxation was permitted the subjects before the push-up test. While in the resting position, the subject was rolled from the chinning to the parallel bars where the identical procedures were repeated as in the pull-up test.

Statistical Analysis

Seven variables were considered in the analysis of data. Three were anthropometric measures, including standing height, body weight, and girth of the flexed, tensed biceps. There were also three measures of arm strength as follows: Rogers' Arm Strength Formula, McCloy's Arm Strength Formula, and the total number of pull-ups and push-ups performed by the subject. The final variable and criterion measure was the energy cost resulting from performing the pull-ups and push-ups, which was measured in cubic centimeters of oxygen.

Correlational Analysis. To determine the existing relationships among the variables, product moment intercorrelations were computed. With 35 cases, it was found that correlation coefficients of at least .325 and .418 were necessary for the coefficients to be significant at the .05 and .01 levels of confidence, respectively (3). The intercorrelations resulted in a total of 21 coefficients ranging from .015 to .893. Seven of the r's were found to be significant at

the .01 level of confidence and four at the .05 level of confidence. The data appear in Table 1.

Of the anthropometric measures, only the correlations between height and weight and the relationship between weight and bicep girth were significant. In both instances, the r's were significant at the .01 level of confidence. The high correlation of .799 between bicep girth and weight is of interest in that it seemingly supports a statement made by McCloy to the effect that arm and shoulder girdle development correlates significantly with total body development.

Anthropometric Measures and Arm Strength

In an earlier study dealing with arm strength and anthropometric measures, Clarke reported correlations of .25 and .15 respectively between standing height and McCloy's and Rogers' arm strength. Of these coefficients, .25 was found to be significant at the .05 level of confidence. In this study, r's of .430 and .358 respectively for the previously mentioned variables were obtained. By contrast, these correlations were found to be significant at the .01 and .05 levels of confidence, respectively. An interesting observation about the correlations is that McCloy's formula seems more closely related to height than does the Rogers formula. McCloy has made no attempt to evaluate height whereas Rogers does incorporate it into his computations.

Weight, when correlated with McCloy's and Rogers' arm strength formulas, resulted in coefficients of .893 and .340 respectively. The large difference is most likely caused by the extreme emphasis McCloy's formula places on weight, whereas Rogers' formula by comparison does not place too much stress on the weight factor.

TABLE 1.—INTERCORRELATION OF ENERGY COST WITH ARM STRENGTH FORMULAS AND SELECTED ANTHROPOMETRIC MEASURES (N = 35)

Variables	1	2	3	4	5	6	7
Mean	72.2	159	13.31	23.07	570.9	614.3	3950.26
σ	2.78	17.34	.88	6.28	62	183.3	916.0
1. Height							
2. Weight	.537[a]						
3. Bicep Girth	.015	.799[a]					
4. Pull-ups + Push-ups	.088	.068	.025				
5. McCloy's Arm Strength Formula	.431[a]	.893[a]	.815[a]	.322			
6. Rogers' Arm Strength Formula	.358[b]	.340[b]	.231	.641[a]	.540[a]		
7. Energy Cost	.114	.328	.250	.302	.405[b]	.298	

[a] Significant at 1 percent level.
[b] Significant at 5 percent level.
Net energy cost for both pull-ups and push-ups ranged from 1684. cc. to 8,097. cc. with a mean of 3950. cc. and a σ of 916. cc.

McCloy's arm strength formula correlated .322 with total pull-ups plus push-ups, while Rogers' formula correlated .641. The obtained r of .815 between bicep girth and McCloy's formula is in close agreement with findings by Clarke (2).

In this study, as well as in the study reported by Clarke, there was no significant relationship between Rogers' arm strength formula and bicep girth. However, one should be cognizant of the fact that while this close relationship has been found with the McCloy formula, there also exists, as determined in this study, a very high relationship between McCloy's arm strength formula and weight ($r = .893$) as well as a high relationship between weight and bicep girth ($r = .799$). When the data were analyzed by means of a partial correlation formula, holding weight constant, the relationship between bicep girth and McCloy's arm strength formula was reduced to .380. Employing the same procedure with the Roger's formula, the coefficient was lowered from .231 to —.074. The only significant correlations with energy cost were between McCloy's formula ($r = .405$) and weight ($r = .328$).

Conclusions

1. Energy cost of the activity is not significantly related to bicep girth or total number of pull-ups plus push-ups.
2. A correlation significant at the .05 level of confidence was obtained between energy cost and weight.
3. A high relationship was found between weight, bicep girth, and the McCloy arm strength formula. The highest r was between weight and the McCloy arm strength formula.
4. Using energy cost as a criterion measure, the study revealed McCloy's arm strength formula slightly more discriminating than the Rogers formula for prediction of arm strength. However, because of the low correlations neither of the formulas could be employed to any significant extent as a predictive measure.

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Hip Flexibility of Elementary School Boys as Related to Body Segments

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Abstract

One hundred and fifty-eight male pupils in elementary school were measured on two hip flexibility tests and several anthropometric measures. The primary purpose was to determine the relationship among the flexibility tests in the anteroposterior plane and the selected anthropometric measures. Results indicate that: (a) no significant relationship exists between flexibility of the hip joint and length of body segments; (b) satisfactory objectivity coefficients were obtained for the flexibility tests and measures of body length; (c) examination of the extremes of the distribution of lower limb length seems to support the fact that flexibility is independent of lower limb length; (d) 46.8 percent of the subjects failed the Wells Sit and Reach Test, while 54.4 percent could not pass the Adapted Kraus-Weber Floor Touch Test.

IN A RECENT STUDY, the authors reported on the hip flexibility of college women as related to length of body segments (3). The results of a similar study dealing with third-, fourth-, and fifth-grade boys are presented in this paper. The purpose was to determine the relationship among two tests of hip flexibility in the anteroposterior plane and three selected anthropometric measures for elementary school boys.

Procedure

The data obtained were gathered from 158 male pupils at the Edison Elementary School, Pullman, Washington. They included (a) age to the nearest tenth of year, (b) standing reach, (c) height, (d) weight, (e) lower limb length of right leg from top of greater trochanter to floor, (f) score on the Wells Sit and Reach Test, and (g) the score obtained on the Adapted Kraus-Weber Floor Touch Test.

Standing Reach. A sheet of cardboard with ½-in. ruled lines was placed on a wooden stand 48 in. above the floor. In stocking feet, each subject stood facing the cardboard with toes and chest touching the wooden stand. The children were instructed to reach as high as possible with both hands. The distance that each subject reached was recorded to the nearest half-inch.

Standing Height. A stadiometer was used to determine the subject's height, measured in stocking feet. The measurements were recorded to the nearest half-inch.

Distance from Greater Trochanter to Floor. The distance from the greater trochanter to the bottom of the foot was measured while the subject stood on a table 3½ ft. from the floor. Markings were placed on the table so that each subject took approximately the same stance as the rest of the group. The top of the greater trochanter was located and measurement was made by means of a steel tape from this point to the top of the table. The measures obtained were recorded to the nearest half-inch.

Wells Sit and Reach Test. A platform scale resting on crossed stem boards and raised a foot from the floor as described by Wells and Dillon (4) was used in this phase of the battery of tests. The subjects sat with their feet firmly placed on the footprints diagramed on the cross board and the backs of both knees held flat on the floor. They were instructed to extend forward with the hands placed palms down on the upper surface of the platform scale. The subject was not allowed to bob forward but rather had to extend forward slowly until a position of maximum reach was obtained. The most distant point reached was held and the reading from the scale was recorded to the nearest half-inch. Each subject was allowed only one attempt.

Adapted Kraus-Weber Floor Touch Test. The subjects were tested in their stocking feet and as described by Kraus and Hirschland (2), with one exception—the test was performed with the subjects standing on a stall bar bench. A 20-in. scale was attached to the bench so that the exact inches the subject could reach were recorded to the nearest half-inch. In this manner, the subject was scored according to the number of inches he could reach either above or below his toes, rather than on a pass or fail basis as described by Kraus and Hirschland. If a subject reached exactly to his toes, a reading of zero was recorded. The scores above the toes were recorded as minus values and the readings below the toes were marked as plus values. The children were allowed only one attempt to reach as far as possible down the 20-in. scale without warm-up and they were not allowed to bob.

Analysis of Data

As the primary purpose of this study was to ascertain the relationship between selected flexibility measures and certain anthropometric data, the objectivity coefficients and intercorrelations for these variables were computed. Calculations, along with means and standard deviations, were made for each grade separately and also for the four grades combined as one group. The coefficients obtained for 158 cases in excess of .159 are significant at the .05 level and in excess of .208 at the .01 level (1). Though analyses were made for each of the four grades separately, much of the discussion will refer to the four grades combined as one group for there were no systematic differences among grades in means, standard deviations, or intercorrelations of tests.

Objectivity Study

To demonstrate competency in administering the two flexibility tests and in obtaining the distance from the greater trochanter to the floor, a test-retest

objectivity study was conducted with a one-week interval between the two test periods. The results of this study appear in Table 1.

TABLE 1.—OBJECTIVITY COEFFICIENTS FOR TWO HIP FLEXIBILITY TESTS AND ONE ANTHROPOMETRIC MEASUREMENT

Test (N = 158)	r
Adapted Kraus-Weber	.89
Wells Sit and Reach	.84
Greater Trochanter to Floor	.98

The correlation of .89 obtained for the Adapted Kraus-Weber Test may be considered satisfactory, although not approaching the objectivity of .98 found in a previous study for 66 college women (3). The correlation of .84 obtained for the Wells Sit and Reach Test is not nearly so high as the *r* of .98 reported by Wells and Dillon in their original investigation with 100 women students (4). However, the correlation does approach the *r* of .87 found by Mathews and others for a flexibility study on 66 college women (3).

It was believed that the *r* of .98 for the measurement of the greater trochanter to the floor could be considered exceptionally high. In a study of the hip flexibility of college women, an objectivity coefficient of .84 was reported. The variation in objectivity coefficients may be not only because of the difference in samples but also because the length of the greater trochanter was not measured in exactly the same manner for the two studies. In the former study, this measurement of length was taken from the center of the trochanter, while in the present study the top of the trochanter was found and the measurement made from this anatomical protrusion.

Comparison of Test Means

In Table 2 are contained the means and standard deviations for each grade separately and for the combined grades on the two flexibility tests and one anthropometric measure. As can be seen from the table, the means for the Adapted Kraus-Weber Floor Touch Test were on the negative side of zero indicating that, for all grade levels and for the total group, the average child

TABLE 2.—MEANS AND STANDARD DEVIATIONS OF SELECTED VARIABLES FOR INDIVIDUAL GRADES AND TOTAL GROUP

	Adapted Kraus-Weber	Wells Sit and Reach	Greater Trochanter to Floor
Third-Grade Mean	— .95	— .44	27.73
N = 32 S.D.	2.58	2.39	1.44
Fourth-Grade Mean	—2.00	— .92	29.74
N = 42 S.D.	2.62	2.61	1.54
Fifth-Grade Mean	—1.39	—1.01	30.37
N = 46 S.D.	2.69	2.52	2.14
Sixth-Grade Mean	— .97	1.18	32.29
N = 38 S.D.	2.85	3.01	1.87
Total-Grades Mean	—1.36	— .34	30.13
N = 158 S.D.	2.70	2.76	2.35

could not touch his toes. The same is true for the Wells Sit and Reach Test, except at the sixth-grade level where the average is just a little over plus one inch. The mean for the distance of the greater trochanter to the floor increases steadily as the children progress in grade level and age.

Correlation of Flexibility Measures

In order to determine whether or not length of the specific body segments was related to the hip flexibility scores, the two tests of flexibility were correlated with the distance from the greater trochanter to the floor, standing reach, and standing height. Table 3 contains the results of this analysis.

TABLE 3.—RELATIONSHIP BETWEEN TWO HIP FLEXIBILITY TESTS AND THREE ANTHROPOMETRIC MEASURES

Tests (N = 158)	r
Adapted Kraus-Weber vs Standing Reach	−.072
Wells Sit and Reach vs Standing Reach	.049
Adapted Kraus-Weber vs Lower Limb Length	−.137
Wells Sit and Reach vs Lower Limb Length	−.020
Adapted Kraus-Weber vs Standing Height	−.088
Wells Sit and Reach vs Standing Height	−.007

As can be seen from the table, the six correlation coefficients are not significant. To be significant at the .05 level for an N of 158, a coefficient of .159 would be required. From these results, one must conclude that the flexibility of the hip joint as measured by these two tests is not related to either standing reach, lower limb length, or standing height for the elementary school boys sampled in this study. The correlation between the Kraus-Weber and the Wells Sit and Reach flexibility tests for the 158 subjects was .73, which indicates a significant agreement between these two measures.

In the administration of the battery of tests, the subject's age and weight were recorded. These two variables were also correlated with the two flexibility tests in order to determine whether or not a relationship existed. The results appear in Table 4.

TABLE 4.—RELATIONSHIP BETWEEN TWO HIP FLEXIBILITY TESTS, AGE, AND WEIGHT

Tests (N = 158)	r
Adapted Kraus-Weber vs Age	.040
Wells Sit and Reach vs Age	.186
Adapted Kraus-Weber vs Weight	−.028
Wells Sit and Reach vs Weight	.031

The intercorrelations obtained between the flexibility tests and weight did not show significance. However, the correlation obtained for the Wells Sit

and Reach Test with age was .186, which is significant at the .05 level. This would indicate that there is no relationship between the subject's ability to touch his toes and his weight, but that some relationship exists between age and the score obtained on the Wells Sit and Reach Test.

Correlations of Limb Length and Height

The 158 pupils were also measured for height, and the statistics obtained were compared with the measurements of the lower limb, from the greater trochanter to the floor. This relationship between height and lower limb length showed an r of .934, which was to be expected since the correlation between lower limb length and standing reach was .939 and that between standing reach and height was .965.

Analysis of Extremes of Distribution

It was of interest to compare the correlations between the anthropometric measures and flexibility scores for the performance of the two extreme groups of children. These two groups comprised the 16 children of the total 158 who had the longest lower limbs and the 16 who had the shortest lower limbs. The average limb length for the high group was 35.66 in. and for the low group, 26.40 in. Means were computed for these two extreme groups of 16 each; they appear in Table 5.

TABLE 5.—COMPARISON OF THE GROUP EXTREMES IN TERMS OF LOWER LIMB LENGTH

Description	High Group N = 16	Low Group N = 16
Height	62.13	50.43
Standing Reach	79.46	63.50
Age	9.44	8.88
Adapted Kraus-Weber	— .87	— .19
Wells Sit and Reach	— 1.00	— .50
Lower Limb Length	35.66	26.40

It is apparent from Table 5, as might be expected from the high correlations already reported between various body length measures, that the high group is almost a foot taller than the low group and that the standing reach of the high group is almost 16 in. more than for the lower group. Also, it is apparent that the high group averages about one-half year older.

Nevertheless, the differences between the two groups on the flexibility tests is indeed slight. On the Kraus-Weber test, which showed a σ of 2.72 for all 158 subjects, there is a mean difference of only .68 in. On the Wells Sit and Reach Test, which showed a σ of 2.80 for all 158, the mean difference between the high group and the low group is only .50 in. Both of these mean differences in flexibility scores fall far short of statistical significance.

The general indication is that the anthropometric measures and the flexibility tests both yield high objectivity coefficients. Although there are sub-

stantial correlations among age and the various measures of body length, and the two flexibility tests agree fairly well, correlations between the body measures and flexibility scores are very low. Furthermore, an analysis of the flexibility scores of group extremes on lower limb length substantiates the near independence of the flexibility scores from the other measures.

Summary

Within the limitations of this study, the following conclusions seem worthy of consideration:

1. Both the Kraus-Weber and the Wells Sit and Reach tests yielded satisfactory objectivity coefficients. Likewise, the measures of body length were satisfactory with respect to objectivity.
2. No significant relationship was found between the three anthropometric measures when correlated against the two flexibility tests.
3. The correlation between the flexibility tests was substantial but not high enough to permit substitution of one test for the other.
4. Age showed moderately high correlation with body length measures and a significant but very low positive correlation with the Wells Sit and Reach Test. The correlation between age and weight was insignificant.
5. Intercorrelations among the three body length measures were in the low 90's.
6. Correlations between body length measures and flexibility scores were very low and statistically insignificant.
7. Examination of the extremes of the distribution of lower limb length seems to support the fact that flexibility is independent of lower limb length.
8. Of the subjects, 46.8 percent could not touch their toes on the Wells Sit and Reach Test, while 54.4 percent could not pass the Adapted Kraus-Weber Floor Touch Test.

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Periodic Changes in the Circulation During Athletic Training as Reflected by a Step Test

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Abstract

A one-minute step test at 36 steps per minute on a 17-in. bench was given to 17 varsity basketball players each three weeks during 16 weeks of training and after 10 and 20 weeks of detraining.

The results indicated that the recovery pulse rate made significant changes in three weeks (.05 level) and highly significant changes in six weeks (.01 level). This level of conditioning was maintained throughout the season to reach a maximum change in 16 weeks.

In 10 weeks of detraining significant reversal changes had occurred so that conditioning was not maintained when the season ended.

PHYSICAL EDUCATORS have been interested in changes brought about by athletic conditioning for many years. It has been found that many significant physiological changes result from athletic training and that simple tests of recovery pulse rates are indicative of the circulatory adjustments (1, 4, 5, 6, 9, 10). Recent studies at Santa Barbara have indicated that a one-minute step test can be used to show stages of conditioning of track and basketball athletes (9).

Since most of the studies concerning athletic training compare athletes with nonathletes or compare before and after conditioning periods, there is a need to show periodic changes during training. This study was conducted to investigate periodic changes during an athletic training program.

Methodology

Subjects. In order to control the workout periods, the first 20 members of the varsity basketball team were used as subjects. Three members of the team were forced to quit due to injuries or scholastic problems so that 17 completed the study. The ages ranged from 19 to 26 yrs. with an average of 21.6 yrs. The heights ranged from 68.5 in. to 77.5 in. with an average of 72.0 in. The weights ranged from 139 to 223 lbs. with an average of 169 lbs.

Experimental Design. The subjects were tested twice during the month of October to become acquainted with the testing procedure. After the second testing period, data were collected every three weeks during the 16-week basketball season. The conditioning program consisted of daily 1½-hr. workouts, five days each week with a three week lay-off in the middle of January due to final examinations and semester registration (January 9-28, 1958).

The measurements were taken at the same time of day at least two hours away from a meal (in order to reduce diurnal fluctuations). The temperature in the laboratory varied from 76°-78° F. The subjects acted as their own control by detraining for ten weeks without participating in any regular exercise program. The subjects then left school for the summer. In September, 14 of the group returned to school and were tested once again after an additional 20-weeks' lay-off from regular exercise. Thus, the data reflect the resting and pulse rate recovery curves taken each three weeks for 16 weeks during training, after ten weeks' detraining, and after 30 weeks of detraining.

Testing Procedure. The subjects were seated for at least five minutes until the resting pulse rates had leveled off for three consecutive counts. They then stepped up and down on a 17-in. bench for one minute at a rate of 36 steps per minute. Using a four-count step up and down, this meant the timing metronome was set at a rate of 144/min. After stepping for one minute, the subject sat down and the postexercise 15-sec. carotid pulse count was taken, starting five seconds following the exercise. The 15-sec. count was again taken at the end of each minute of recovery for five minutes. This count was multiplied by four in order to convert the rate to a one-minute count.

The tests were given by one of the authors while the other controlled the daily workout periods which consisted of normal basketball drills and scrimmages.

Statistics Used. Since the pulse rate was expected to decrease during training and rise during detraining, single tailed t-ratios were used as being significant. The difference method of computing the t's was used since paired scores are correlated (7). The double tailed test was used when comparing data between the different months of nontraining (October-May-September), because the authors were interested in whether there were any significant differences, plus or minus, when the subjects were not training.

Day-to-Day Variation of the Data. In order to test the day-to-day fluctuations of the test given, the subjects were given two tests within three to six days of each other when training was not being carried on. The results showed that insignificant changes occurred in these test-retest trials. The resting pulse rate had a mean difference of 2.4 $\pm$ 1.8 beats per minute. The immediately-after-exercise pulse count had a mean difference of 5.1 $\pm$ 3.0 beats per minute. The one-minute-after count had a mean difference of 2.3 $\pm$ 2.7. The two-minute-after count had a mean difference of 2.5 $\pm$ 2.3. The three-minute-after count had a mean difference of 4.0 $\pm$ 1.6.

The reliability correlations were .81 at rest, .56 at one-minute recovery, .86 at two-minute recovery, and .89 at the three-minute count.

The immediately-after pulse count reliability was only .42 and this probably accounts for the inconsistent changes made during the study.

Results

Figure I shows the pulse rate recovery curves when taken during the various testing periods. There were two groups formed, depending on

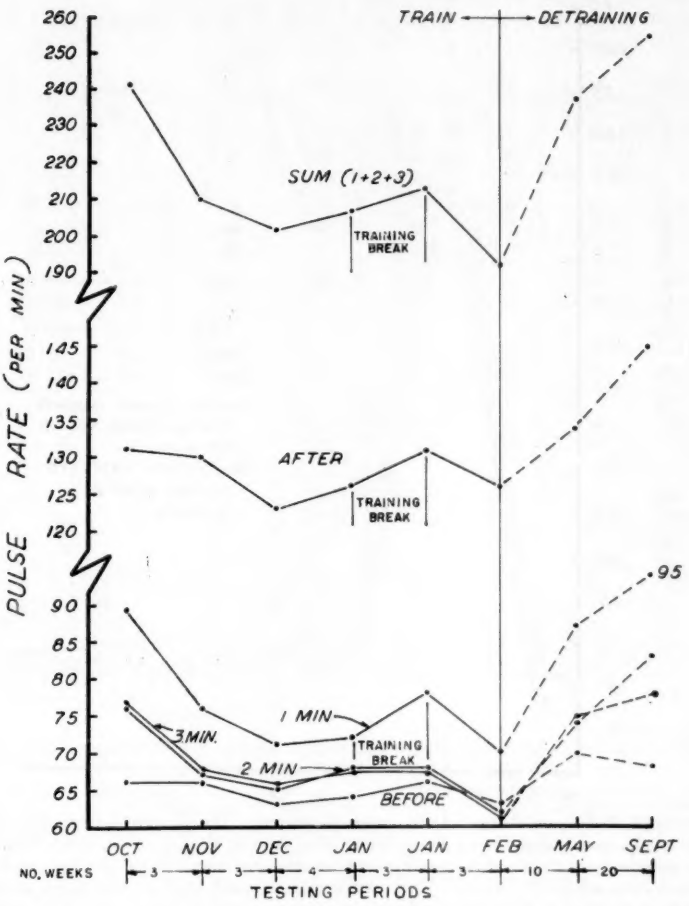

FIGURE I. Pulse rate per minute curves taken before, immediately after, and each minute during recovery from a one-minute step test on a 17-inch bench, at the rate of 36 steps per minute. The 15 second times four pulse counts were used.

whether or not the group was in training during the preceding period. The three dashed tracings (October, May, and September), when training was not going on, show higher resting and recovery pulses not returning to the resting level in five minutes. The mean counts following training periods show lower resting and recovery pulses and also a tendency to recover to the resting rate in two to three minutes.

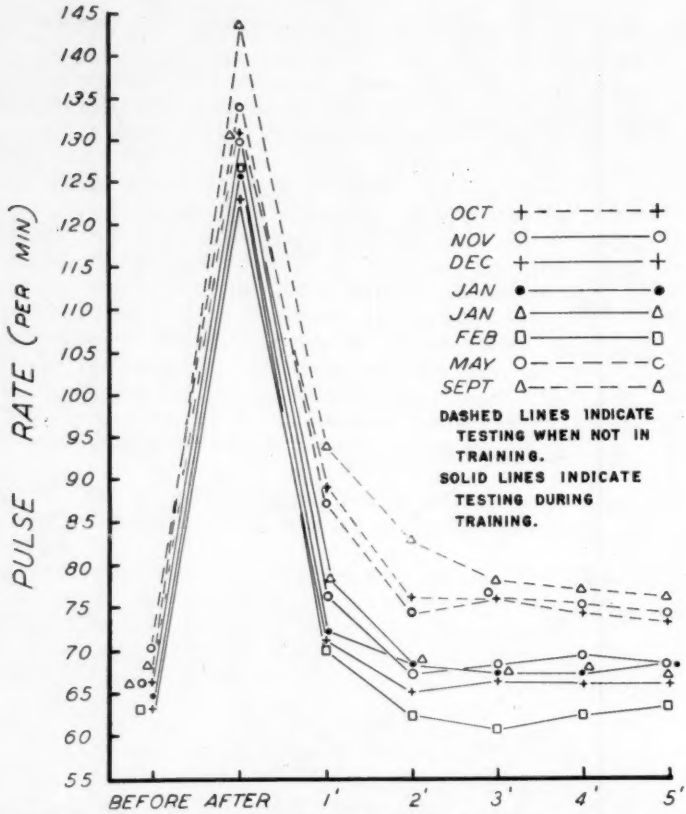

FIGURE II. Pulse rate changes during physical training. The 15 second times four pulse rate counts were taken before, immediately after, and at the one, two, three, four, and five minute recovery times following a one minute step test. Since the four and five minute rates are nearly the same as the three minute count, they are not shown to avoid crowding the figure. Note that in February, after 16 weeks' training, the two and three minute recovery pulse counts were lower than the resting before exercise count.

Figure II shows the mean changes made with the resting and recovery pulse counts during training and detraining. The resting and recovery pulse counts decreased during the first six weeks, then leveled off for seven weeks. The maximum amount of decrease occurred in February, after 16 weeks of training. Within ten weeks of detraining the pulse counts had returned to the level found in October when training began. During the three-week training break in January, the pulse counts reversed themselves and then again decreased when training resumed.

TABLE 1.—MEAN PULSE RATE/MINUTE MEASUREMENTS BEFORE AND FOLLOWING A ONE-MINUTE STEP TEST ON 17-INCH BENCH, 36 STEPS-MINUTE

		Resting	Immediately After	1 Min.	2 Min.	3 Min.	4 Min.	5 Min.
Oct 29	M	66	131	89	76	76	74	73
	σ	9.08	13.4	10.4	8.16	7.12	6.99	7.35
	σ_M	2.27	3.35	2.60	2.04	1.78	1.75	1.84
Nov 18	M	66	130	76	67	68	69	68
	σ	10.52	9.80	15.82	11.72	13.09	12.42	12.02
	σ_M	2.63	2.45	3.96	2.93	3.27	3.10	3.00
Dec 9	M	63	123	71	65	66	66	66
	σ	9.18	14.55	8.45	8.17	8.14	7.90	9.00
	σ_M	2.29	3.64	2.11	2.04	2.04	1.98	2.25
Jan 7	M	64	126	72	68	67	67	68
	σ	8.0	12.45	13.5	11.83	9.68	8.96	9.65
	σ_M	2.0	3.11	3.38	2.96	2.42	2.24	2.41
Jan 27	M	66	131	78	68	67	67	67
	σ	8.35	12.7	9.30	7.32	8.75	7.40	9.04
	σ_M	2.08	3.18	2.32	1.83	2.19	1.84	2.28
Feb 17	M	63	126	70	62	60	62	63
	σ	7.10	8.0	10.8	8.2	4.95	5.15	4.65
	σ_M	1.77	2.0	2.7	2.05	1.24	1.29	1.16
May 8	M	70	134	87	74	76	75	74
	σ	6.78	15.7	15.6	13.0	11.3	10.3	7.06
	σ_M	1.70	3.93	3.91	3.26	2.94	2.58	1.77
Sept	M	69	144	94	83	78	77	76
	σ	8.68	21.75	14.15	12.3	13.9	11.7	12.5
	σ_M	2.41	6.04	3.93	3.86	3.80	3.25	3.47

TABLE 2.—MEAN PULSE RATE CHANGES BETWEEN PRETRAINING TESTS IN OCTOBER AND TESTS DURING TRAINING

	Oct to Nov N=17		Oct to Dec N=17		Oct to Jan 7 N=17		Oct to Jan 27 N=17		Oct to Feb N=17	
	Mean Difference Pulse/min.	t	Mean Difference Pulse/min.	t	Mean Difference Pulse/min.	t	Mean Difference Pulse/min.	t	Mean Difference Pulse/min.	t
Resting	0	0	−3	1.25	−2	.76	0	0	−3	1.14
Immediately After	−1	.34	−8	1.79[a]	−5	1.12	0	0	−5	1.51
1 Minute After	−13	3.17[b]	−18	5.59[b]	−17	4.74[b]	−11	3.02[b]	−19	5.43[b]
2 Minutes After	−9	2.38[a]	−11	4.12[b]	−8	2.58[b]	−8	2.91[b]	−14	5.51[b]
3 Minutes After	−8	2.20[a]	−10	3.12[b]	−9	3.12[b]	−9	3.52[b]	−16	8.25[b]
4 Minutes After	−5	1.59	−8	3.19[b]	−7	2.89[b]	−7	2.95[b]	−12	5.80[b]
5 Minutes After	−5	1.75[a]	−7	4.24[b]	−5	2.58[b]	−6	3.00[b]	−10	5.71[b]

[a]Single tailed t, significance beyond the .05 level (1.75).
[b]Single tailed t, significance beyond the .01 level (2.58).

TABLE 3.—PULSE RATE CHANGES BETWEEN TESTS DURING DETRAINING PERIODS

	Feb to May N=16		Feb to Sept N=14		May to Sept N=14		Oct to May N=16		Oct to Sept N=14	
	Mean Difference/ Min.	t_1	Mean Difference/ Min.	t_1	Mean Difference/ Min.	t_2	Mean Difference/ Min.	t_2	Mean Difference/ Min.	t_2
Resting	7	3.38[b]	6	1.53	−1	.296	4	1.36	3	.93
Immediately After	8	2.09[a]	18	4.80[b]	10	1.93	3	.65	13	3.00[a]
1 Minute After	17	7.11[b]	24	6.74[b]	7	1.47	−2	.41	5	.89
2 Minutes After	12	4.54[b]	21	5.38[b]	9	1.81	−2	.49	7	1.58
3 Minutes After	16	5.40[b]	18	4.94[b]	2	.398	0	0	2	.43
4 Minutes After	13	5.08[b]	15	4.01[b]	2	.47	1	.29	3	−88
5 Minutes After	11	6.43[b]	13	3.79[b]	2	.55	1	.36	3	−93

Key:
t_1 single tailed t
t_2 double tailed t

[a]Significant beyond .05 level
[b]Significant beyond .01 level.

Table 1 presents the descriptive statistics of the pulse rate counts, and Tables 2 and 3 show the mean changes along with the t-ratios.

The mean resting pulse rate dropped from 66 to 63 beats per minute between October and December (six weeks), then rose to 66 in January during the lay off of three weeks and finally dropped again to 63 during February and the end of training. This measurement never quite reached .05 significance (1.75). The resting pulse rate made the greatest change during the first six weeks of training. Following the training period, the resting pulse rate increased to 70 by May and to 69 in September. The increase from the end of training in February to May (ten weeks detraining) reached the .01 level of significance but was insignificant between February and September (20 weeks detraining).

The resting pulse rate did not change significantly during training as has been reported elsewhere (3, 8). Since the psychological factors affecting resting pulse rates are difficult to control, it is possible that errors in testing did not allow statistical significance to be shown. It is suggested in this study that the "true" resting pulse rate was to be found following the exercise and perhaps was not the rate recorded before stepping. From Table 1, it is seen that the pulse rate had returned to a plateau within one or two beats per minute of the resting rate after 3 minutes of recovery time in December, January, and February.

It is seen from Table 2 that during these weeks of training the three-, four-, and five-minute recovery pulse rates made highly significant changes between October and the months of December, January, and February (6, 10, 13, 16 weeks of training). Since the pulse rate after recovery from exercise did make highly significant changes with training and if we accept this measurement as the "true" resting rate, then it is most probable that the resting pulse rate is a significant measurement to indicate states of train-

ing. The difficulty in estimating the "true" resting pulse rate may be lessened with a light exercise period. This possibility should be investigated.

The mean postexercise pulse rate taken immediately after the exercise decreased from 131/min. in October to its lowest count of 123/min. in December. This measurement paralleled the resting count by then increasing to 131/min. during the training break in January and reversing to 126/min. during the last three weeks of training. The postexercise pulse count just reached significance (at the .05 level) between October and December, but at no other time during training did it reach this level (Table 2). During detraining it increased from 126/min. in February to 134/min. in May (.05 level) and to 144 in September (.01 level), as indicated in Table 3.

Significant changes in the recovery pulse rate occurred by November (three weeks), as indicated by the pulse counts reaching the .05 level except at the four-minute count. By December, after six weeks of training, the .01 level of significance was reached at each of the five-minute recovery counts and this was maintained until February when training ceased (Table 2). Between February and May, after ten weeks of detraining (Table 3), the recovery pulse counts increased at each minute and made significant changes in the opposite direction, thus confirming the training changes. The recovery pulse rates showed no significant differences between May and September when an additional 20 weeks of detraining occurred. This and the insignificance seen between October and the other months when training was not in progress (May or September) verify the fact that ten weeks after training stopped the effects of the "conditioning" had been nullified, at least with respect to the pulse rate test.

The sum of the pulse counts at the one-minute, two-minute, and three-minute recovery times decreased from 241 in October to 192 in February (.01 level) and then increased to 237 in May and to 255 in September (.01 level).

The pulse rate increased 65 beats per minute from resting to exercise in October and changed very slightly during the training period. There was always about 65/min. mean pulse rate rise during the exercise regardless of training (Table 4). The resting to one-minute-after-exercise difference changed from 23 in October to 7 in February and returned to 25 in September (Table 4). Table 3 shows that there were no significant differences in the measurements taken between October, May, and September when training was not in progress.

TABLE 4.—MEAN PULSE RATE DIFFERENCES/MINUTE BETWEEN RESTING AND POSTEXERCISE MEASUREMENTS

Resting to Immediate After Differences						Detraining	
Oct.	Nov	Dec	Jan 7	Jan 28	Feb	May	Sept
65	64	66	62	65	63	64	75
Resting to One-Minute After Differences							
23	10	8	8	12	7	17	25

Discussion

The recovery pulse rate decreased during the first six weeks of training, then leveled off for three weeks. When training resumed in January, an additional three weeks reversed the pulse rate to its maximum amount. This same plateau after six weeks of conditioning was reported by Michael (8) with respect to track training as reflected by the resting pulse rate and the stroke volume of the heart. It appears that after three to six weeks of hard conditioning there is a plateau or leveling-off period. The authors do not know the result of conditioning for longer than the time reported here since there is no report in the literature of similar changes found with training and detraining. The pattern of three- to six-week plateaus appears to be either a "psychological drive span" or a true physiological cycle.

The authors have found that either the sum of the recovery pulse counts taken at one, two, and three minutes following exercise or the count taken only at one minute indicates training changes very well. It is preferred to use the sum count because there is less chance for an error in counting only once. In regard to the 15-second count, less error has been found when the counting stops before the pulse rate reaches too many double figures. Many of the assistants complain when the 30-second or one-minute count is used because they forget the count. The 15-second count was also used because of the rapid drop-off following exercise and the wish to estimate the pulse count near the peak.

With regard to the step test used, no subject in this experiment failed to finish the test, while Keen (6) reports that 22 of his subjects failed to complete the Harvard Step Test. The one-minute test used at Santa Barbara causes an increase in pulse rates that recover in five to ten minutes when training is not being carried on. After six to eight weeks of training the recovery usually occurs in two to three minutes.

Results of other studies at Santa Barbara indicate that the sum of the 15-second pulse recovery counts taken at one, two, and three minutes after the exercise and multiplied by four (to convert to rate/minute) averages about 300 for the normal male college students, 250 for physical education majors, and 200 for trained athletes.

Summary

A one-minute step test at 36 steps per minute on a 17-in. bench was given to 17 varsity basketball players each three weeks during a 16 weeks' season of physical training, again after 10 weeks of detraining, and after 20 additional weeks of detraining. The results indicated that the recovery pulse rate count made significant changes during the training for a basketball season. The training caused changes in three weeks (.05 level) and highly significant changes (.01 level) in six weeks. Maximum changes occurred in 16 weeks. After six weeks of training, a plateau was reached and no significant changes occurred when training was continued an additional ten weeks. Three weeks of lay-off after ten weeks of training caused a reversal of the recovery pulse

rates but the change was not statistically significant. Three additional weeks of training again improved the fitness level to a maximum point. In ten weeks of detraining, the circulatory changes had reversed significantly so that conditioning was not maintained when daily workouts stopped.

The one-minute-after-exercise pulse count and the sum of the one-, two-, and three-minute recovery pulse rates changed in a parallel fashion during physical conditioning for basketball. The pulse rate did not recover to the resting level for five minutes following the exercise when the training program was not being followed. During the training period, however, the pulse rate had recovered by the second or third minute after the exercise.

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Effects of Ethyl Alcohol on the Performance of Selected Gross Motor Tests[1]

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Abstract

The purpose of this investigation was to study the effect of ethyl alcohol in various concentrations on the performance of a selected battery of physical performance test items. Tests were administered three days each week: (a) the day before consuming alcohol, (b) at the peak of the blood concentration, and (c) the day following the drinking. Residual effects were not found to be significant in 24 hours, whereas drinking alcohol on the day of performance did significantly affect performance. The speed and reaction skill indicated the least decrease in efficiency, followed by the bicycle ergometer, which primarily measures endurance. Highly co-ordinated skills and strength type performance seemed to decrease most in efficiency.

THE USE OF ALCOHOL and alcoholic beverages has been a topic of controversy throughout history. Some records of research and histories of people emphasize the disastrous influence of alcohol on the human body (2), while other records include beneficial effects under certain conditions.

More specifically, in education the approach to teaching about alcohol has been focused principally on the physiological damage resulting from its use, followed by inferences that it is detrimental to physical performance under all conditions. Teachers of health classes, athletic coaches, and physical educators have emphasized its effect on the body in reducing athletic performance. Consequently, many generalized statements have been made about alcohol that are not fully substantiated. This has led to a number of misunderstandings, since alcohol is used in many different ways and people differ in their reactions when it is consumed.

Controlled experiments on alcohol and emotions, as well as work with fine motor skills, are numerous, but apparently little evidence is available on the effects of various concentrations of alcohol on gross motor skills. Not only is evidence lacking of the effect of alcohol during performance, but nothing seems to be available on the physiological effects at various time intervals after the oxidation of the alcohol.

It seems appropriate that controlled research be done to answer some of the questions associated with alcohol and the performance of gross motor skills found in physical education, recreation, and athletic programs.

The purpose of this investigation was to study the effect of ethyl alcohol in various concentrations on the performance of a selected battery of physical performance test items. The tests appear to contain many of the basic com-

[1] This study was supported by Utah State University research funds.

ponents found in physical fitness, as well as the ability to perform athletic types of activity.

Subjects

Subjects were 30 male students of Utah State University. All were in good physical condition, since most of them were participating in competitive athletics and the intramural program.

Procedure

The study was set up as a cross over design (1: 127, 3)[2] and included five men in each of six groups (see Table 1). Three different drinks (one each

TABLE 1.—EXPERIMENTAL DESIGN

Group[a]	Amount of Alcohol		
	First Week	Second Week	Third Week
I	None	2 oz.	3 oz.
II	3 oz.	None	2 oz.
III	2 oz.	3 oz.	None
IV	None	3 oz.	2 oz.
V	2 oz.	None	3 oz.
VI	3 oz.	2 oz.	None

[a]Total of 30 subjects, 5 in each group.

week) containing no alcohol, two ounces, and three ounces of 200 proof ethyl alcohol were administered to each subject. This design for this number of treatments is two specially constructed 3 x 3 Latin Squares. The design was created to control two sources of variation and also to measure any possible residual effects of one treatment upon the following treatment, since all treatments are applied sequentially to the same exprimental unit. If one observes the design critically, it may be noted that each treatment follows every other treatment an equal number of times. This characteristic allows the experimenter to measure both the direct effects of the treatments and any residual effects that may be present. If the residual effects do not show up, the design may also be analyzed as two repetitions of a 3 x 3 Latin Square. The latter statistical analysis is much simpler and is based on a less complicated theory (3).

The tests were administered three days each week: (a) the day before consuming alcohol, (b) at the peak of the blood concentration, which was 30 min. following the last of three drinks (drinking covered a 45-min. period), and (c) the day following the drinking. All tests were given at the same time during each day and on the corresponding day each week.

The consumption of the beverage was carefully controlled. Only small groups of three or six subjects were utilized at any one time and subjects

[2] After analysis, the data were treated as two repetitions of a 3 x 3 Latin Square, as explained on p. 315.

from all six groups, or one from each of the first three or the last three groups, were included.

Since there appears to be bias and stigma attached to the use of alcohol, it was considered essential to control emotional factors during the drinking situation. Subjects were told they may or may not be drinking alcohol and that the experiment involved different amounts of alcohol. A topical anaesthetic was used on the tongue of each subject prior to the consumption of the alcohol and a nose clip was used during the drinking. In addition, the drinks were carefully mixed with Tom Collins mix, lemon juice, maraschino cherries, and ice. A total of three 10-oz. glasses of liquid was consumed on each drink day. The alcohol, when present, was equally distributed in the three drinks. Even though some subjects did not receive alcohol on a given day, they consumed a beverage the same as those who had alcohol in their drinks.

Since the alcohol concentration in the blood is dependent upon the size of a person's liver, which is in turn related to body size, various amounts were given to each person, depending on his weight. The exact amount of 2 oz. or 3 oz. was given if the subject weighed 160 lb., with proportionately more or less, depending on how much more or less he varied from the base weight. The amount was ½ oz. for each 50 lbs. over or under the base weight, and then in turn broken down according to the subject's weight. If, for example, a subject weighed 236 lbs., which is 76 lbs. over the base of 160, he received ¾ oz. more than the prescribed level.

Blood concentration of alcohol is dependent upon many conditions which include the contents of the stomach. Therefore, beverages were ingested during the noon hour, on an empty stomach.

Tests

The physical performance tests were selected to test such basic components as strength, endurance, speed and reaction time, power, and a complex throwing skill. These items are believed to be a part of physical fitness and many gross motor, athletic types of activity. The tests were given in the sequence listed so that the effects from one test to another would be uniform.

TEST 1. GRIP STRENGTH

Righ hand grip strength, measured with a dynamometer, was used as an index of strength.

TEST 2. SPEED AND REACTION

An upright starting position was used with each subject running 10 yds. The electric timing device was started by clapping two copper covered boards together. As the sheets of copper came together, the clock started and continued until the runner broke the electric circuit by striking a gate switch, waist high, across the finish line. Time was recorded to the nearest 1/100 sec. Each subject's score included the average of five timed trials.

TEST 3. SOFTBALL THROW (ACCURACY)

Subjects were given 10 warm-up throws followed by 15 scored throws from a distance of 40 ft. The target was an archery target lined with five concentric circles six in. apart. Scoring was on the basis of five for bulls' eye, and one less for each circle away from the center.

TEST 4. VERTICAL JUMP

The subject reached as far as possible with heels kept on the floor and made a chalk mark on the wall. He next executed three jumps from a crouched position, making a finger imprint each time on the wall board. The distance from the top of the reach mark to the top of each jump mark was measured. The average of three jumps was used as the score.

TEST 5. BICYCLE ERGOMETER

Maximum number of revolutions in 45 sec. against a 10-lb. resistance was attempted.

TEST 6. PUSH-UPS

Ten minutes after the ergometer test, each subject did as many push-ups as he could. Requirements for the skill conformed to standard procedure, and the total score was in terms of the number completed successfully.

Measurement Techniques[3]

The experiment was designed as a cross-over, but after analyzing the test scores for the day following the consumption of alcohol, it was found that the differences were not significant. Hence it was felt that there could not be any residual effect at the end of a week. The data were treated, therefore, as two repetitions of a 3 x 3 Latin Square, which resulted in a much simpler analysis of variance than that required for a cross-over design.

Results

Comparisons were made of the three test days and the three levels of alcohol on the six skills, and it was found that the residual effects of 200 proof ethyl alcohol (these were the tests made the day following the administration of alcohol) were not significant in 24 hours (Table 2).

However, the effects of 2 oz. and 3 oz. of alcohol were found to affect significantly the performance of five of the six skills as measured one-half hour after administering the alcohol. Consequently, the analysis of data was confined to the immediate effects of the alcohol.

The analysis of variance of the effects of the different amounts of 200 proof ethyl alcohol is found in Table 3. The F test was performed according to standard procedures (1) (5). The probabilities were then found by compar-

[3] Statistics on this project were completed in the Utah State University Laboratory under the direction of Rex Hurst.

TABLE 2.—RESULTS OF TESTS MADE THE DAY BEFORE, ONE-HALF HOUR AFTER, AND THE DAY AFTER INGESTING VARIOUS AMOUNTS OF ALCOHOL. AVERAGES OF 30 SUBJECTS

Test	Amount of Alcohol Consumed	Scores Day Before	Scores Under Influence of Alcohol	Scores Day After
Bicycle Ergometer (revolutions)	None	226.4	229.0	231.6
	2 oz.	226.8	219.9	227.4
	3 oz.	228.3	210.0	230.5
	Avg.	227.2	219.6	229.8
Speed and Reaction (seconds)	None	2.246	2.253	2.224
	2 oz.	2.238	2.306	2.241
	3 oz.	2.244	2.852	2.241
	Avg.	2.243	2.304	2.236
Softball Throw (accuracy)	None	48.1	46.8	48.2
	2 oz.	48.1	44.0	45.7
	3 oz.	46.0	40.1	46.8
	Avg.	47.4	43.6	46.9
Vertical Jump (inches)	None	21.25	21.48	21.62
	2 oz.	21.48	20.43	21.51
	3 oz.	21.78	19.12	21.48
	Avg.	21.51	20.34	21.54
Grip Strength (pounds)	None	115.8	114.2	116.3
	2 oz.	117.9	112.1	117.6
	3 oz.	118.3	112.7	117.0
	Avg.	117.3	113.0	116.9
Push-Ups	None	31.8	32.7	33.5
	2 oz.	31.6	29.1	32.6
	3 oz.	30.7	27.3	32.2
	Avg.	31.4	29.7	32.8

ing computed values of F with tabular values; only the probabilities are recorded, to conserve space (see Appendix).

Table 4 contains the results of tests in terms of change from the control day and the day of consuming alcohol. The standard error of the change compares no alcohol with 2 oz. of alcohol and no alcohol with 3 oz. of alcohol.

In terms of percent change from the control day (Table 5), push-ups, which purport to measure strength and endurance, dropped more than any of the skills (11% with 2 oz. and 16.5% with 3 oz.). The other four tests (ergometer, speed and reaction, softball throw, and vertical jump) seem to

TABLE 3.—ANALYSIS OF VARIANCE OF THE EFFECTS OF VARIOUS AMOUNTS OF 200 PROOF ALCOHOL

		Mean Squares					
	d.f.	Bicycle Ergometer (revolutions)	Speed and Reaction (seconds)	Softball Throw (accuracy)	Vertical Jump (inches)	Grip Strength (pounds)	
Squares	1	115.60	.002561	22.50	9.8672	30.04	44.10
Rows Within	4	284.74	.034129	112.34	26.2218	1149.69	254.59
Columns Within	4	239.07	.001296	21.37	2.1028	12.09	164.09
Treatments	2	2709.10 (.005)[a]	.074647 (.005)[a]	339.70 (.025)[a]	41.6968 (.005)[a]	36.63	229.81 (.25)[a]
Error	6	49.50	.001487	35.96	2.7968	70.39	95.00
Individuals	72	559.05	.019800	67.64	6.7276	301.02	194.60
Total	89						

[a]The probability of getting as large an F value due to chance is less than the value in parentheses.

TABLE 4.[a]—CHANGE FROM CONTROL TESTS AND TESTS MADE ONE-HALF HOUR AFTER INGESTING 2 AND 3 OZ. OF 200 PROOF ALCOHOL

	Bicycle Ergometer (revolutions)	Speed and Reaction (seconds)	Softball Throw (accuracy)	Vertical Jump (inches)	Grip Strength (pounds)	Push-Ups
2 oz.	− 9.1	+.053	−2.8	−1.05	−2.1	−3.6
3 oz.	−19.0	+.099	−6.7	−2.36	−1.5	−5.4
Standard Error of Change	1.82	.0099	1.09	.305	1.53	1.78

[a]These data may also be presented in terms of the various legitimate t tests (see Appendix).

TABLE 5.[a]—PERCENT CHANGE FROM CONTROL DAY AND TESTS MADE ONE-HALF HOUR AFTER INGESTING 2 AND 3 OZ. OF 200 PROOF ALCOHOL

	Bicycle Erogometer (revolutions)	Speed and Reaction (seconds)	Softball Throw (accuracy)	Vertical Jump (inches)	Grip Strength (pounds)	Push-Ups
2 oz.	−3.9	+2.4	− 6.0	− 4.9	−1.8	−11.0
3 oz.	−8.3	+4.4	−14.6	−11.0	−1.3	−16.5
Standard Error of Change	.79	.44	2.33	1.42	1.34	5.44

[a]These data may also be presented in terms of the various legitimate t tests (see Appendix).

be reduced two-fold in proficiency with the addition of 1 oz. of alcohol (from 2 oz. to 3 oz.). The softball throw for accuracy, which is an intricate, learned skill, is reduced more than twice in proficiency. It also shows more decrease —6 percent reduction in proficiency, with 2 oz. of alcohol and 14.3 percent reduction with 3 oz. (Table 5). Changes in grip strength and push-ups may be accounted for as measuring error.

Discussion

There is very little question about certain physiological effects of alcohol on man, although many of the conditions and reasons for change still remain rather nebulous.

Even though there were significant group differences in terms of decreased efficiency in all six tests under the influence of 2 and 3 oz. of 200 proof alcohol, there were still some individuals who did not conform to this group pattern. For example, one subject performed consistently better under the influence of alcohol, and others performed some skills better when alcohol was ingested.

As might be expected, alcohol reduces performance for most people, but in some individuals it apparently improves performance by reducing inhibitions.

There were no residual effects of alcohol in 24 hours (day after tests) found in this study, but it should be mentioned that in a 24-hour period

recuperation could be easily completed. It is possible to get extra rest and have the body recover sufficiently to perform the tests equally as well as on the control day. The maximum amount of alcohol used in the experiment (3 oz.) is the equivalent of six drinks over the bar, assuming each drink to have 1 oz. of 100 proof whiskey. It should be remembered that drinking bouts usually have many other factors, such as dancing and other activity, emotional involvements with people, eating and drinking other ingredients, lack of sleep and rest, etc., all of which could be detrimental in terms of physical performance. Circumstances such as these are not always considered when alcohol is on the scene.

It is interesting to note the effects of fatigue and alcohol combined. The traumatic effect of alcohol, along with many other drugs, is greater when a person is tired. Consequently, there could have been some effect on the push-ups resulting from fatigue which was created as a result of riding the bicycle ergometer ten minutes prior to their being performed. At any rate, the comments of the subjects concerning fatigue and the subjective observation on performance when alcohol was given were most indicative of this phenomenon. When subjects completed the tests after drinking alcohol they appeared to be much more fatigued than on nondrinking days and recovery appeared to be much slower.

Subjects often complained of not feeling well later in the day and also indicated feeling worse the following day, even though performance was not significantly affected. Many comments were made concerning how early they retired or how much more rest they required when they had had alcohol. This may have helped them to recover sufficiently after 24 hours to bring performance back to normal.

The coefficient of variation seems worthy of mentioning, since this type of experimental design may be useful in future work. Table 6 indicates that

TABLE 6.—COEFFICIENT OF VARIATION FOR THE PHYSICAL PERFORMANCE TESTS

	Bicycle Ergometer (revolutions)	Speed and Reaction (seconds)	Softball Throw (accuracy)	Vertical Jump (inches)	Grip Strength (pounds)	Push-Ups
Coefficient of variations	3.20%	1.67%	13.75%	8.22%	7.42%	32.82%

the measurements were most precise (repeatability) for the speed and reaction (C.V. = 1.67%) and the bicycle ergometer (C.V. = 3.20%); push-ups, though adequate for this study, were the least precise test in measurement (C.V. = 32.82%).

The reasons for the precision seem to be:

(1) the care in handling and controlling the testing, and

(2) the type of design, which allows one to remove any extraneous variation by having each individual serve as his own control.

Conclusions

1. Residual effects of 2 and 3 oz. of 200 proof ethyl alcohol were not found after 24 hours.
2. Drinking alcohol on the day of performance did significantly affect performance on the tests selected for study.
3. The timing device used in the speed and reaction test and the bicycle ergometer seemed to be the most precise measuring instruments as evidenced by the small coefficient of variation.
4. Four of the six skills (speed and reaction, ergometer, softball throw, vertical jump) decreased approximately two-fold in proficiency from 2 oz. to 3 oz. of alcohol.
5. When the tests of the control day were compared with tests made under the influence of alcohol, the speed and reaction test followed by the bicycle ergometer (endurance) indicated the least percent change in proficiency.

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Appendix

Examples given refer to the bicycle ergometer test, and computation of coefficient of variation could be extended to the other performance tests.

$$1.\ \text{C.V.} = 100\,\frac{\sqrt{\text{Error Mean Square}}}{\text{Mean}} = 100\,\frac{\sqrt{49.50}}{219.6} = 3.20\%$$

The coefficient of variation for the bicycle ergometer test is computed by taking the error mean square (Table 3) 49.50, extracting the square root, and dividing the over-all mean from Table 2, 219.6.

2. Computation of F.

$$F_{(2,6)} = \frac{\text{Treatment Mean Square}}{\text{Error Mean Square}} = \frac{2709.10}{49.50} = 54.729$$

The F value for the bicycle ergometer test is computed by taking the treatment mean square, 2709.10, and dividing it by the error mean square.

$F_{(.005)(2,6)} = 14.544$

Hence, the probability is less than .005 of getting such a result due to chance.

3. Computation of standard error of change

$$\text{s.e.} = \frac{\sqrt{2\ \text{Error Mean Square}}}{\text{number of observations}} = \frac{\sqrt{(2)\ (49.50)}}{30} = 1.82$$

The standard error of change is computed by taking the square root of twice the error mean square $\sqrt{(2)\ (49.50)}$ and dividing by the number of observations used to obtain the mean (30). A t test may be constructed by dividing the change by the standard error of change, i.e., $t_6 = \frac{-19.0}{1.82} = 10.44$

$t_{(.001)(6)} = t\ 5.959$

Hence, the probability is less than .001 of getting such a difference due to chance.

(Submitted 11/3/58)

Comparison of Base Running Methods

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Abstract

This study measured the difference in time used to run to first base between running directly to and beyond the base in normal stride and leaping at the base in the final stride. Fifteen college varsity baseball players served as subjects and had 12 trials with each method. The mean time for the first method was .0117 seconds faster. Eleven subjects reached the base more quickly by running straight through. Four were more effective by leaping.

THE PROBLEM was to determine whether running through or leaping at a finish point was the faster technique. A lack of agreement upon this is indicated by the following quotations:

In the case of the runner on the track, the base runner in baseball, and the hurdler, it is desirable to avoid rising in the air as much as possible. The objective in these and similar instances is to move from one point to another in the shortest space of time. Therefore, these athletes are not interested in prolonging their flight through the air. It is interesting to note how many base-runners erroneously leap in their last stride to first base or hop as they take a lead off a base and are put out as a result (1).

Using his spectacular jump finish, Charley Paddock bolstered his reputation as "the world's fastest human" by winning two American sprint titles 30 years ago this week.... To win, the 24-year-old Paddock had to defeat Loren Murchison, the defending champion, and his foremost American rival in both events. A fast starter, the Newark A. C. dash star (Murchison) led the 100-yard dash until the last 10 yards. At that point Paddock drove his powerful legs hard, climaxing the effort with a tremendous jump toward the finish line (2).

The former viewpoint is reflected in the teachings of most baseball coaches with particular reference to the run to first base when it is obvious that the play will be close and the runner needs to reach the base as quickly as possible. Runners are instructed to run at and beyond first base using their normal stride and are cautioned against taking the above-mentioned leap on the last stride.

Because of the complete absence of experimental data dealing with this topic and because plays at first base are often decided by extremely minute measurements of time, this study was undertaken in order to obtain data which reflect the superiority of one method or which indicate the absence of significant difference between methods.

Procedure

The subjects were selected from varsity baseball players at Springfield College. The purpose of the study and the manner in which it was to be

conducted were explained to these persons and 15 volunteered their services as subjects.

The measurement procedure utilized a 1/100-sec. clock with the starting and stopping of the clock caused by electrical stimuli. An arbitrary distance, which was 28 ft. 6 in. from first base, was established as the point at which timing was to start. A switchmat, 22 in. long by 12 in. wide, was placed on the base line, extending from the above-indicated distance toward first base. As the runner contacted the mat, the timing began. Another switchmat was placed on first base where the contact with the runner's foot stopped the clock. All times were read to the closer 1/200 sec.

Although the distance actually timed was only the last 28.5 ft., all subjects stood at home plate in normal batting stance, were told which method of touching the base to use, swung at an imaginary pitch, and then ran as quickly as possible to first base. To avoid including any differences in ability to get away from home plate or in speed of acceleration, the point of initiating the timing was set sufficiently far to assure that each individual had already attained complete acceleration and still far enough from first base to permit either method to be executed as it would be in a game. Thus, such differences as occurred could be attributed to the method of contacting first base.

Similarly, every effort was made to have the conditions comparable to those existent in a baseball game and every run toward first base was begun at home plate. The one exception to game conditions was that the subjects wore basketball shoes rather than baseball shoes to avoid cutting the switchmats in the numerous trials. Because sufficient space was given for acceleration and because no pivoting or other change from a straight-line direction was involved, it is felt that this difference in footwear in no way exerted an influence upon the results obtained.

The testing was begun in the latter part of October 1958 and completed in early November. In all but one testing period, the site for the testing was the varsity baseball field. On that one occasion, inclement weather necessitated the use of indoor facilities. The college field house was utilized and the appropriate distances were measured off.

Before any of the running was done for record, all subjects were given a practice period to acquaint themselves with the two methods. The instruction in and practice of the leap at the base were given greater emphasis since the players were already familiar with the other method. All subjects were instructed that when leaping they should take off at a distance permitting the end of the leap to coincide with the near side of first base and were cautioned against unnecessary height in the leap. The suggestion was made that they visualize the first baseman in an outstretched position awaiting the throw and that they make the utmost effort to contact first base as quickly as possible. While accustoming himself to the leaping method, each subject used a take off marker at the proper point beside the base path in order to get the maximum leap while ending it at the aforementioned point.

The instructions for the run-through method were those commonly used: namely, to run as quickly as possible toward first base, to touch the base with whichever foot was in position, and to continue running at full speed until at least 5 yds. beyond first base.

The number of practice trials varied among the subjects and the criterion for the mastery of each method was the author's subjective evaluation. No one was timed until he had satisfied this criterion. In the case of the leaping method, the mean number of practice trials was approximately 20.

The testing pattern for any single period consisted of two trials using each method twice or a total of four to any set. Each day when testing was conducted, subjects were required to engage in warm-up activities and practice sprints before testing, both as a precaution against injury and as assurance that the times obtained would be indicative of actual ability to perform. The proper distance for take off on the leap was also measured during this period. In every instance, a minimum of two minutes' rest was observed between trials to minimize any fatigue effects. To further equalize any effects from either insufficient warm-up or fatigue from previous trials, a rotation plan was employed using all possible combinations while still having two trials which ended in a leap and two where the subject ran straight through the base. This resulted in six different testing periods or a total of 12 trials with each method for each of the 15 participants.

TABLE 1.—TESTING PATTERN

First Period				Second Period				Third Period			
#1	#2	#3	#4	#1	#2	#3	#4	#1	#2	#3	#4
Leap	Leap	Run	Run	Run	Run	Leap	Leap	Run	Leap	Run	Leap
Fourth Period				**Fifth Period**				**Sixth Period**			
#1	#2	#3	#4	#1	#2	#3	#4	#1	#2	#3	#4
Leap	Run	Leap	Run	Leap	Run	Run	Leap	Run	Leap	Leap	Run

Analysis of Data

The standard error of the difference between correlated means was used to analyze the data. Because each testing period contained two scores for each method, the total of the two trials terminating in a leap was correlated against the total of the two trials in which the subject ran right through and beyond the base. The correlation obtained in this manner was .793. Mean scores for all subjects were calculated on the two methods. From these, mean scores for the group were determined, and running straight through the base proved faster by .0117 seconds. This difference resulted in a t of 1.65 compared to 2.14 required for significance at the .05 level with 14 degrees of freedom.

Because composite figures can often obscure pertinent information concerning individual results, the times for each of the participants were also analyzed in terms of differences in average time with the two methods. As

TABLE 2.—INDIVIDUAL RESULTS OF THE TWO METHODS

Subject	M_{Leap}	M_{Run}	D	Preference	SE_{Diff}	t
1	1.034	1.007	.027	Run	.0084	3.21[a]
2	1.070	1.086	.016	Leap	.0097	1.65
3	1.023	1.015	.008	Run	.0109	.73
4	.977	.945	.032	Run	.0048	6.67[a]
5	.984	.974	.010	Run	.0085	1.18
6	1.008	1.012	.004	Leap	.0063	.63
7	1.080	1.127	.047	Leap	.0060	7.83[a]
8	1.001	.996	.005	Run	.0044	1.14
9	1.017	1.006	.011	Run	.0070	1.57
10	1.025	1.017	.008	Run	.0050	1.60
11	1.026	.993	.033	Run	.0090	3.67[a]
12	1.051	1.019	.032	Run	.0072	4.44[a]
13	1.065	1.012	.053	Run	.0068	7.79[a]
14	1.024	1.034	.010	Leap	.0098	1.02
15	1.107	1.073	.034	Run	.0058	5.86[a]

[a]Significant at the .01 level.

shown in Table 2, 11 of the subjects obtained superior results by running through in normal stride, with the difference significant beyond the .01 level for six. The other four subjects achieved better times by taking the leap at the base. One of the latter group had a mean difference which was significant well beyond the .01 level.

Implications of Study

The results of this study should be of value to persons interested in baseball techniques because they present experimental evidence concerning an issue which has to date been discussed on a theoretical or empirical basis. The data give some evidence as to the superiority of the procedure whereby the runner continues his stride and runs right through the base rather than leaping at it in a long stride. It must be borne in mind, though, that the subjects were skilled baseball players who have been trained in the procedure of running through the base. In spite of orientation in and practice of the leaping method as a part of the study, it is possible that even longer periods of practice might enable them to reduce their time while finishing the run to first base in this manner.

This study appears to validate customary teaching in baseball which prescribes running through in normal stride and provides justification for the continuation of such teaching. It is recognized that the difference in time between the two methods is an extremely small one and that it is possible for human judgment, as represented by a base umpire, to err to a greater degree than is portrayed by this time difference. However, where the difference between being safe or out is so very minute, as it often is in baseball, evidence in favor of a specific technique to minimize the time required makes that technique one which coaches should use with members of their squads. At the same time, coaches should recognize that some players had superior performances using the leaping technique. Thus, it is possible

that coaches might discover certain persons who, for varying reasons, get better results with the leap. To insist that all execute the run to first base in an identical manner, then, would prevent some from optimum performance. As in all teaching, consideration must be given to individual differences, and the technique of base running prescribed for a player should be that one with which he is most successful rather than the one which has proven most effective for others.

It would be of value to have a study of this type undertaken with young boys just learning baseball who would not bring to it already developed proficiency in one or the other method. It might be possible in this manner to appraise even more accurately whether one method possesses definite superiority over the other.

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(Submitted 11/14/58)

Electromyographic Studies of Arm Movements[1]

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Abstract

By means of electromyography the contractions of the following biarticular muscles were studied: the long head of the biceps brachii, the short head of the biceps brachii, the long head of the triceps brachii, and the pronator teres. Electromyograms were recorded from four subjects by a model III-D Grass electroencephalograph. Surface electrodes were used for all electromyograms that were recorded for this study.

IT WAS THE PURPOSE of this study to observe the contractions of the biarticular muscles involved in prescribed movements of the arms. The biarticular muscles studied were the long and short heads of the biceps brachii, the long head of the triceps brachii, and the pronator teres.

The movements selected for study were such that, if the biarticular muscles contracted, they would aid the movement at the one joint and would hinder the movement at the other joint. For example, in the two-arm press (pushing a bar-bell upward to arm's length overhead from a position in front of the chest) the long head of the triceps brachii has the ability to extend the forearm, but if it contracted, it would tend to hinder flexion of the arm. This movement, together with similar movements, was selected for study.

Related Studies

Duchenne (2) studied the movements produced by various muscles by means of electrical stimulation. He found that the long head of the triceps brachii extends the forearm with much less force than does either the lateral head or the medial head of the triceps brachii. With the hand held in pronation, electrical stimulation of the biceps brachii caused supination of the hand and flexion of the forearm. If the biceps brachii was in strong contraction because of an electrical stimulation, any effort to pronate the hand met with strong resistance. When the forearm was held in extension with the hand pronated while an electrical current was introduced to the biceps brachii, the hand became supinated. The strength of supination was greater, however, if the forearm was flexed before the current was applied to the biceps brachii. Electrical stimulation of the long head of the biceps brachii alone produced a very weak supination of the hand. Electrical stimulation of the pronator teres while the hand was in supination caused the forearm to

[1] This study was submitted in 1954 in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Division of Physical Education in the Graduate College of the State University of Iowa, under the direction of C. H. McCloy.

flex with moderate force if pronation was resisted. Electrical stimulation of the pronator teres while the hand was held in pronation caused the forearm to flex with a weak force.

In an electromyographic study reported by McCloy (4) one of the muscle parts studied was the long head of the triceps brachii. The subject stood with a 15-lb. dumbbell in the hand and with the trunk bent forward about 45 deg. from the vertical. From this position the forearm was extended sharply and the arm raised backward and away from the medial line of the long axis of the body about 40 deg. In this movement the long head of the triceps brachii contracted moderately. From the same position as that above, the elbow was extended and the arm raised backward and toward the medial line of the long axis of the body, with the upper arm pressing against the latissimus dorsi. In this movement the long head of the triceps brachii contracted strongly.

Miles and others (5) found that the magnitude of the action-potentials produced in the biceps brachii varies when the forearm is flexed with the hand in either supination or pronation.

Procedure

A 4-channel model III-D Grass electroencephalograph using a paper speed of 60mm per sec. was used to record the electromyograms that were taken for this study. Before application of the surface electrodes, the skin surface was roughened with a safety razor and wiped with acetone to remove the oil. The electrodes were then filled with electrode paste and attached either with collodion or with adhesive tape a distance of approximately 1.5cm from center to center.

In this study the skin resistance between a given pair of electrodes was never greater than 15,000 ohms. In the majority of cases this resistance was less than 10,000 ohms.

The electrodes were placed, as nearly as possible, equidistant from the motor point of the muscle being tested. The motor points of the muscles were found by the use of an inductorium. As a guide for determining the approximate positions of the motor points of the muscles studied, the charts of motor points from two different sources (1, 3) were used. The electrodes were attached in such a way that a line drawn from the center of one electrode to the center of the other electrode was approximately parallel to the muscle fibers.

For this study it was necessary to use three amplification settings of the electroencephalograph. For the chinning exercise, an amplification setting was used which gave a pen deflection in one direction of 9mm when an input voltage of 1000 microvolts was introduced to the pen-writers. An amplification setting which gave a pen deflection of 7mm in one direction when an input voltage of 500 microvolts was introduced to the pen-writers was used for the two-arm press. For all other exercises an amplification setting was used which gave a pen deflection of 7mm in one direction upon the intro-

duction to the pen-writers of 200 microvolts input voltage. Pen deflection or calibration was determined both before and after each session of recordings.

These three calibration settings were necessary because of the great variation in the strength of contraction of the muscles from which recordings were taken. For example, flexion of the forearm in the movement of chinning would cause the biceps brachii to contract with a great deal of force. On the other hand, flexion of the forearm without resistance would produce very little contraction of the biceps brachii.

The subject himself served as the resistance for the chinning exercise. For the two-arm press a barbell weighing 45 lbs. was used. All other exercises were performed both with and without resistance. Depending upon the exercise to be performed, this resistance consisted of a dumbbell, a wall-pulley, or an overhead-pulley. The dumbbell weighed approximately 10 lbs. To move the wall-pulley and the overhead-pulley required a force of approximately 10 lbs. With the exception of chinning, all exercises were performed with the subject in the standing position. In all ten of the movements of this study the arm and the forearm moved in the sagittal plane.

Four subjects were used in this study. Three were male students in the University High School of Iowa City, Iowa. Each of these three subjects was tested until at least two similar recordings were made for each muscle involved in the movements studied. The fourth subject was a professor in the Division of Physical Education at the State University of Iowa. One complete set of muscle recordings was made from this subject. For all movements studied the electromyograms were recorded from the muscles of the right side of each subject.

Since the degree of tenseness of the subject and the speed with which the movements were performed would have some bearing on the amplitude of the electromyograms recorded, each subject was told to perform the movements in a slow, relaxed manner. This eliminated the possibility of ballistic-type movements and of excessive tenseness during the execution of the movements.

The movement of flexion of the arm to the front horizontal position and extension of the forearm along with the movement of extension of the arm and flexion of the forearm from the front horizontal position were evaluated at the following points:

I. Beginning of movement
II. Point midway between I and III
III. End of movement.

All other movements in this study were evaluated at the following points:

I. Beginning of movement
II. Point midway between I and III
III. Point at which the arm forms an angle of 90 degrees with the forearm
IV. Point midway between III and V
V. End of movement.

The electromyograms were marked at the desired points for evaluation by the co-operation of the subject and the operator of the electroencephalograph. For example, in the two-arm chins, as the subject performed the movement he said "begin," "mark," "mark," "mark," "stop." The operator placed a mark in line with the pen writers on the recording paper for each of these commands. In this way it was possible to evaluate the electromyograms of the movement at the desired points: I, II, III, IV, V.

In order to evaluate the electromyograms at the specified points it was necessary to devise a marking system to represent the magnitude of the pen deflections at these specified points. The following system was arbitrarily devised for the three amplitude settings used in this study:

A marking of "0" was given to the record if the pen deflection ranged from 0 to 4mm. This represented little or no action-potentials recorded.

A marking of "1" was given to the record if the pen deflection ranged from 5 to 12mm. This represented weak action-potentials recorded.

A marking of "2" was given to the record if the pen deflection ranged from 13 to 20mm. This represented moderate action-potentials recorded.

A marking of "3" was given to the record if the pen deflection was 21mm or above. This represented strong action-potentials recorded.

In addition to this, a letter was also assigned as follows:

If the action-potentials were increasing in magnitude at the point being analyzed, the letter "i" was assigned.

If the action-potentials were decreasing in magnitude at the point being analyzed, the letter "d" was assigned.

If the action-potentials were remaining approximately the same at the point being analyzed, the letter "s" was assigned.

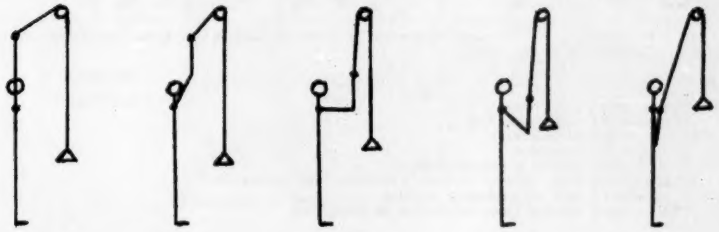
Findings

The findings of this study are presented in the following four tables. A complete description of the movements found in each table (these movements are presented by number in the tables) immediately precedes the table.

DESCRIPTION OF MOVEMENTS PRESENTED IN TABLE 1

1. Two-arm chins with the hands in the supinated position.
2. Extension of arm and flexion of forearm from vertical position overhead (both with and without overhead-pulley resistance).

A diagram of the side views of the movement is shown below.



3. Extension of arm and flexion of forearm from front horizontal position (both with and without wall-pulley resistance from in front of the subject).
   A diagram of the side views of the movement is shown below.

TABLE 1.—MOVEMENTS REQUIRING ARM EXTENSION AND FOREARM FLEXION

Movement Number[a]	Action-Potentials Recorded														
	Biceps (Long head)					Biceps (Short head)					Triceps (Long head)				
	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V
1-UM	1s	3d	2d	1d	0d	2d	2d	3d	1d	0d	0i	1i	0s	0s	0s
1-DM	0s	0i	2i	2d	0s	1i	1d	2i	2d	0s	0i	0s	0s	0s	0s
2-P-WOR	0s	0s	0s	1i	0i	0d	0s	0s	0s	0s	0s	0s	0s	0s	0s
2-P-WR	0s	0i	0i	1d	0s	0s	0s	0s	0d	0s	0s	0s	0s	0s	0s
2-S-WOR	0s	0i	1s	1d	0s	0s	0i	0s	0d	0d	0s	0s	0s	0s	0s
2-S-WR	2d	1s	1i	1d	0i	2s	2d	1i	2s	2s	0s	0s	0s	0s	0s
2-M-WOR	0i	0s	0d	0i	0s	0s	0s	0d	0s	0s	0s	0s	0s	0s	0s
2-M-WR	1d	0s	1d	0i	0s	1s	1s	1i	2d	0d	0s	0s	0s	0s	0s
2-SP-WOR	0d	0s	0s	1s	1d	0s	0s	0s	0s	0s	0s	0s	0s	0s	0s
2-SP-WR	1d	0d	0i	1s	0s	0s	0s	0s	0s	0s	0s	0s	0s	0s	0s
3-P-WOR	0s	0i	0s			0s	0i	0s			0s	0s	0s		
3-P-WR	2s	3i	3d			1i	2i	2d			0s	0s	0s		
3-S-WOR	1i	1d	0s			0s	1s	0s			0s	0s	0s		
3-S-WR	2i	3d	2s			3s	3i	2d			0s	0s	0s		
3-M-WOR	0s	0d	0s			0s	0i	0s			0s	0s	0s		
3-M-WR	2i	3d	2d			2i	2i	2d			0s	0s	0s		
3-SP-WOR	0s	0i	1d			0s	0i	1d			0s	0s	0s		
3-SP-WR	1i	2i	2s			2d	0i	2s			0s	0s	0s		

[a] See "Description of Movements Presented in Table 1" for a complete description of the movements appearing in this table.

Key:

UM — upward movement
DM — downward movement
WOR — without resistance
WR — with resistance
P — hand held in pronated position
M — hand held midway between pronation and supination
S — hand held in supinated position
SP — hand moving from supination to pronation.

Table 1 presents a summary of the action-potentials recorded in movements requiring arm extension and forearm flexion. Figure I presents a recording of action potentials for Movement 1 of Table 1. It should be noted that Movements 2 and 3 without resistance, due to the force of gravity,

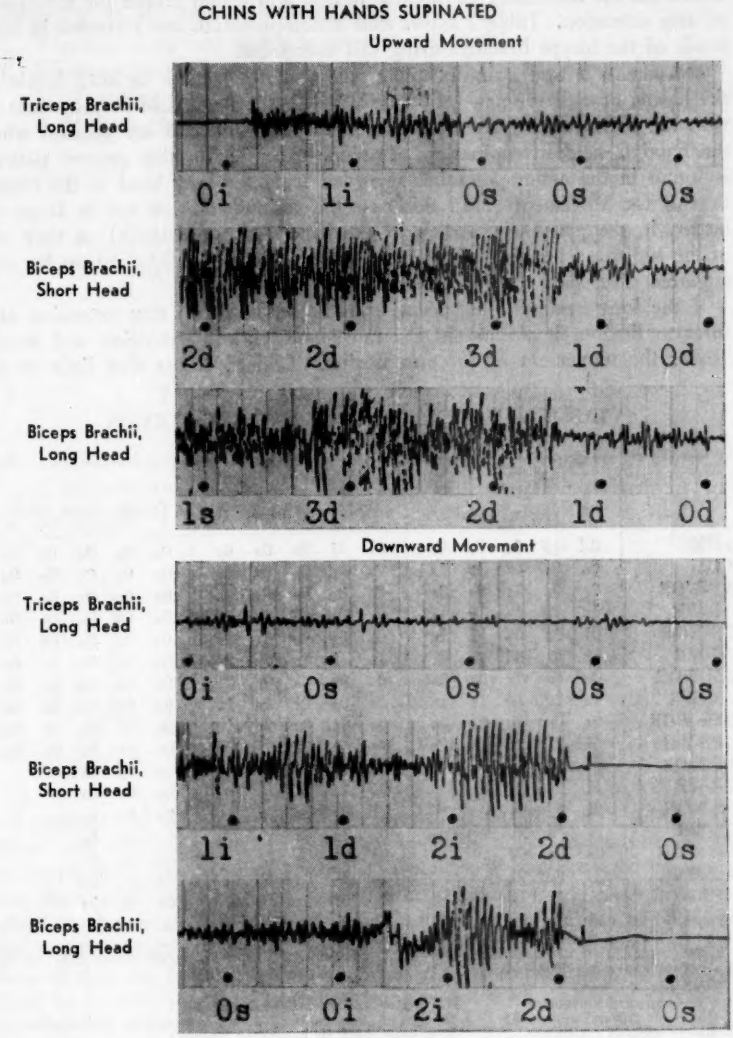

CHINS WITH HANDS SUPINATED
Upward Movement
Triceps Brachii, Long Head
0i 1i 0s 0s 0s
Biceps Brachii, Short Head
2d 2d 3d 1d 0d
Biceps Brachii, Long Head
1s 3d 2d 1d 0d
Downward Movement
Triceps Brachii, Long Head
0i 0s 0s 0s 0s
Biceps Brachii, Short Head
1i 1d 2i 2d 0s
Biceps Brachii, Long Head
0s 0i 2i 2d 0s

FIGURE I. A recording of action potentials.

utilize the same muscles as arm flexion and forearm extension. With overhead-pulley resistance Movement 2 utilizes the same muscles as the two-arm chins (Movement 1).

If the biceps brachii contracted in arm extension and forearm flexion, it would aid the movement of forearm flexion and would hinder the movement of arm extension. Table 1 shows that action-potentials are recorded in both heads of the biceps brachii during this movement.

Movements 2 and 3 indicate that the action-potentials in both heads of the biceps brachii are generally smallest with the hand held in pronation or with the hand moving from supination to pronation and are greatest when the hand is held in supination. The one exception to this general pattern is found in the action-potentials recorded from the long head of the biceps brachii for Movement 3. In this case the action-potentials are as large, or larger, in the pronated position of the hand (with resistance) as they are in the supinated position of the hand (with resistance). The reason for this apparent discrepancy is not known.

If the long head of the triceps brachii contracted in arm extension and forearm flexion, it would aid the movement of arm extension and would hinder the movement of forearm flexion. Table 1 shows that little or no

TABLE 2.—MOVEMENTS REQUIRING ARM FLEXION AND FOREARM EXTENSION

Movement Number[a]	Action-Potentials Recorded: Biceps (Long head) I	II	III	IV	V	Biceps (Short head) I	II	III	IV	V	Triceps (Long head) I	II	III	IV	V
1-UM	0d	1d	0s	0s	0s	0i	1i	0s	0s	0s	0s	0s	0s	0s	0s
1-DM	0s	0i	0i	1s	1s	0s	0s	0s	0s	0s	0s	0s	0s	0s	0s
2-P-WOR	0s	0s	0s	0s	0s	0s	0s	0s	0s	0s	0s	0s	0s	0s	0s
2-P-WR	1s	1s	1s	1s	1s	0s	0i	0i	1s	1d	0s	0s	0s	0s	0s
2-S-WOR	0i	0s	0s	0i	1s	0s	0s	0s	0i	0s	0s	0s	0s	0s	0s
2-S-WR	1i	2i	3d	2i	2i	1s	1i	2s	2s	2s	0s	0s	0s	0s	0s
2-M-WOR	0s	0s	0s	0s	0s	0s	0s	0s	0s	0s	0s	0s	0s	0s	0s
2-M-WR	1s	2d	1s	1s	1s	0s	0s	0i	1s	1s	0s	0s	0s	0s	0s
2-PS-WOR	0s	0s	0i	2s	2s	0s	0s	0s	2d	1s	0s	0s	0s	0s	0s
2-PS-WR	0i	1i	2s	2s	2s	0s	0s	0i	1i	2d	0s	0s	0s	0s	0s
3-P-WOR	0i	0s	0s			0s	0s	0s			0s	0s	0s		
3-P-WR	1i	2i	2d			0i	3d	2i			0s	0s	0s		
3-S-WOR	0i	0d	0s			0i	0s	0s			0s	0s	0s		
3-S-WR	2i	3d	2i			0i	3s	3s			0s	0s	0s		
3-M-WOR	0s	0s	0s			0s	0s	0s			0s	0s	0s		
3-M-WR	2s	2d	2i			1s	3s	3s			0s	0s	0s		
3-PS-WOR	0i	1s	1s			0s	0i	0s			0s	0s	0s		
3-PS-WR	2i	3s	3s			2i	3i	3s			0s	0s	0s		

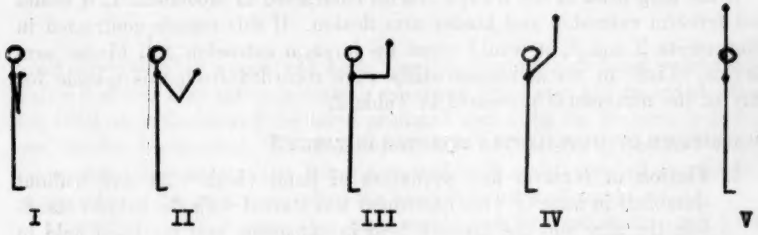
[a] See "Description of Movements Presented in Table 2" for a complete description of the movements appearing in this table.

Key:
UM — upward movement
DM — downward movement
WOR — without resistance
WR — with resistance
P — hand held in pronated position
M — hand held midway between pronation and supination
S — hand held in supinated position
PS — hand moving from pronation to supination.

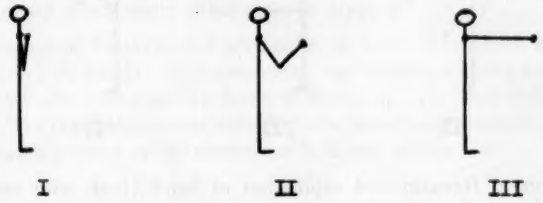
action-potentials are recorded from the long head of the triceps brachii for the three movements presented except at one point in the upward movment of the two-arm chins. At this point weak action-potentials are recorded from the long head of the triceps brachii.

DESCRIPTION OF MOVEMENTS PRESENTED IN TABLE 2

1. Two-arm press with hands in the pronated position.
2. Flexion of arm to vertical position overhead and extension of forearm (both with and without dumbbell in hand).
   A diagram of the side views of the movement is shown below.



3. Flexion of arm to front horizontal position and extension of forearm (both with and without dumbbell in hand).
   A diagram of the side views of the movement is shown below.



A summary of the action-potentials recorded in movements requiring arm flexion and forearm extension is shown in Table 2. In Movement 1 (the two-arm press) the center of gravity of the barbell was closer to the body than the elbow joint and, thus, the forearm extensors would have to act to extend the forearm. In Movements 2 and 3 the center of gravity of the forearm and the dumbbell was farther from the body than the elbow joint. Because of this, the forearm flexors would lengthen (eccentric contraction) to allow the forearm to extend at the desired speed.

If the biceps brachii contracted in Movement 1, it would aid arm flexion and hinder forearm extension. If the biceps brachii contracted eccentrically in Movements 2 and 3, it would aid both forearm extension and arm flexion. From Table 2 it can be seen that weak action-potentials were recorded for the biceps brachii for Movement 1. For Movements 2 and 3, without resistance, weak action-potentials were recorded, and with dumbbell resistance stronger action-potentials were recorded.

The position of the hand affected the strength of the action-potentials recorded for Movements 2 and 3. The smallest action-potentials were recorded with the hand pronated and the largest action-potentials were recorded with the hand supinated or moving from pronation to supination.

If the long head of the triceps brachii contracted in Movement 1, it would aid forearm extension and hinder arm flexion. If this muscle contracted in Movements 2 and 3, it would speed up forearm extension and hinder arm flexion. Little or no action-potentials were recorded from this muscle for any of the movements presented in Table 2.

DESCRIPTION OF MOVEMENTS PRESENTED IN TABLE 3

1. Flexion of forearm and pronation of hand (both with and without dumbbell in hand). This movement was started with the subject standing, the arm and the forearm held in extension, and the hand held in the supinated position. As the forearm was flexed, the hand was pronated. A diagram of the side views of the movement is shown below.

2. Flexion of forearm and supination of hand (both with and without dumbbell in hand).

The starting position was with the subject standing, the arm and the forearm extended, and the hand held in the pronated position. This movement was performed in the same manner as Movement 1 above except that the hand was supinated as the forearm was flexed. In Movement 1 above the hand was pronated as the forearm was flexed.

The action-potentials from the muscles studied for the movement of forearm flexion are presented in Table 3.

If the biceps brachii contracted as forearm flexion was performed together with pronation of the hand, it would aid forearm flexion and hinder hand pronation. If the biceps brachii contracted as the forearm flexed and the

TABLE 3.—MOVEMENTS REQUIRING FOREARM FLEXION

Movement Number[a]	Biceps (Long head)					Biceps (Short head)					Pronator Teres				
	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V
1-SP-WOR	0s	0s	0s	0i	1s	0s	0s	0s	0s	0s	0i	1s	0i	0i	0s
1-SP-WR	2i	3s	3s	3d	1s	2i	3s	2s	2d	0s	2s	2s	2s	1i	0s
2-PS-WOR	0s	0s	0d	0i	2d	0s	0s	0s	0s	0s	0i	0s	0s	0i	0d
2-PS-WR	0i	2s	3s	3d	2d	0i	2s	3s	2s	2d	0i	1s	1s	1s	0s

[a] See "Description of Movements Presented in Table 3" for a complete description of the movements appearing in this table.

Key:

WOR — without resistance
WR — with resistance
SP — hand moving from supination to pronation
PS — hand moving from pronation to supination.

hand supinated, it would aid both forearm flexion and hand supination. Table 3 shows that action-potentials of about equal size are recorded when the forearm is flexed and the hand pronated and when the forearm is flexed and the hand supinated. The action-potentials are smaller at the end of the movement when the hand is being pronated with resistance and are smaller at the start of the movement when the hand is being supinated.

A contraction of the pronator teres would aid forearm flexion and hand pronation in Movement 1 of Table 3. A contraction of this muscle would aid forearm flexion and hinder hand supination in Movement 2 of Table 3. Action-potentials are recorded from this muscle for both of these movements but are much larger for forearm flexion and hand pronation with resistance than for forearm flexion and hand supination with resistance.

DESCRIPTION OF MOVEMENTS PRESENTED IN TABLE 4

1. Extension of forearm and pronation of hand (both with and without dumbbell in hand). This movement was started with the subject standing, the arm extended, the forearm flexed, and the hand held in supination. As the forearm was extended, the hand was pronated. A diagram of the side views of the movement is shown below.

TABLE 4.—MOVEMENTS REQUIRING FOREARM EXTENSION

Movement Number[a]	Biceps (Long head)					Biceps (Short head)					Pronator Teres				
	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V
1-SP-WOR	0s	0s	0d	0s	0s	0s	0s	0s	0s	0s	0s	0i	0d	0s	0s
1-SP-WR	2s	2i	2d	1i	0s	1s	1i	1i	1s	0s	1s	1s	1d	0s	0s
2-PS-WOR	0s	0s	0s	0s	0s	0s	0s	0s	0s	0s					
2-PS-WR	0s	0s	0s	0s	0s	0s	0s	0i	0s	0d					

[a] See "Description of Movements Presented in Table 4" for a complete description of the movements appearing in this table.

Key:
WOR — without resistance
WR — with resistance
SP — hand moving from supination to pronation
PS — hand moving from pronation to supination.

2. Extension of forearm and supination of hand (both with and without overhead-pulley resistance).

This movement was started with the subject standing, the arm extended, the forearm flexed, and the hand held in pronation. The movement was performed in the same manner as Movement 1 above except that the hand was supinated as the forearm was extended. Also, the resistance used in this movement was an overhead-pulley whereas in Movement 1 the resistance was a dumbbell.

Table 4 presents a summary of forearm extension performed simultaneously with other movements. Movement 1 was performed both with and without a dumbbell in the hand. Movement 2 was performed both with and without overhead-pulley resistance. In Movement 1 both with and without resistance and in Movement 2 without resistance the forearm flexors would contract eccentrically to allow the forearm to extend at the desired speed. For Movement 2 with overhead-pulley resistance the forearm extensors would contract to produce forearm extension.

If the biceps brachii contracted eccentrically in Movement 1, it would aid forearm extension and hinder hand pronation. Table 4 shows that moderate action-potentials were recorded for the biceps brachii during extension of the forearm and pronation of the hand.

If the biceps brachii contracted in Movement 2 with overhead-pulley resistance, it would aid hand supination and hinder forearm extension. Little or no action-potentials were recorded from the biceps brachii during this movement.

An eccentric contraction of the pronator teres would aid extension of the forearm and pronation of the hand in Movement 1 of Table 4. This muscle contracted with weak force. The pronator teres was not studied in connection with Movement 2 of Table 4.

A comparison of the electromyograms of the four subjects used in this study revealed a close similarity in the patterns produced by the subjects for the same muscles studied in a given movement. In a great majority of cases increases or decreases in the magnitude of the action-potentials recorded from a muscle in a specific movement occurred at approximately the same

place in the movement for each of the four subjects. Although the pattern of the electromyograms was quite similar, the magnitude of the electromyograms showed much variation among the four subjects.

Summary

Both heads of the biceps brachii aid the movements that require arm extension and forearm flexion (see Table 1). The amount of aid given to these movements is dependent upon the position in which the hand is held. Generally speaking, the smallest action-potentials are recorded from these muscle parts when the hand is held in pronation or when the hand is moving from supination to pronation. The action-potentials from these two muscle parts is largest when the hand is held in supination.

Weak action-potentials were recorded from both heads of the biceps brachii in the movement in which a contraction of these muscle parts would aid flexion of the arm and hinder extension of the forearm (see Table 2).

Both heads of the biceps brachii aid the movement of forearm flexion and hand pronation as well as the movement of forearm flexion and hand supination. The action-potentials recorded in these muscle parts are smaller at the end of the movement when the hand is being pronated and are smaller at the start of the movement when the hand is being supinated (see Table 3).

Little or no action-potentials were recorded from both heads of the biceps brachii in the movement in which a contraction of these muscle parts would aid hand supination and hinder forearm extension (see Table 4).

Little or no action-potentials were recorded from the long head of the triceps brachii in movements in which a contraction of this muscle part would aid arm extension and hinder forearm flexion. (See Table 1.)

Little or no action-potentials were recorded from the long head of the triceps brachii in the movement in which a contraction of this muscle part would aid forearm extension and hinder arm flexion. (See Table 2.)

The pronator teres aids the movement of forearm flexion and hand pronation as well as the movement of forearm flexion and hand supination. The action-potentials recorded from this muscle are much larger in forearm flexion with the hand being pronated than are the action-potentials in forearm flexion with the hand being supinated (see Table 3).

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(Submitted 2/11/58)

A Health Knowledge Test for the Seventh Grade[1]

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Abstract

A valid and reliable instrument was developed for the purpose of measuring the extent of health knowledge possessed by seventh grade pupils. Appropriate vocabulary burden, level of difficulty, and curricular validity were primary factors considered in item formulation. Experimental test forms were subjected to an extensive refinement process prior to the construction of two final, alternate test forms. The alternate forms were administered in a random sample of public schools in Indiana. Analysis of test results yielded statistical evidence of the equivalence of forms.

HEALTH EDUCATORS have the challenging task of helping youth to acquire an understanding of concepts consistent with desirable health behavior. The successful fulfillment of this task requires the intelligent selection and organization of course content and learning experiences which best meet pupil health needs. More effectively planned health instruction is made possible when significant data regarding pupil health knowledge are available to the health educator. Thus measurement devices which reliably reveal strengths and inadequacies within the group are essential to appraise curricular content and to guide teaching.

The purpose of this study was to construct a valid and reliable instrument for measuring the health knowledge of seventh grade pupils. This investigation represents an attempt to provide one instrument which will help to meet the need for health knowledge tests at each grade level as indicated by a review of the literature (1, 4, 12, 16).

Review of Related Research

One reason for the great lack of experimentation in the field of health education is that valid and reliable instruments for measuring health knowledge have not been available (16). A review of the research indicates a continuing lag in the development of health knowledge tests with comparatively few tests being developed during the past decade. Most of the tests reviewed were devised for use at several grade levels (2, 3, 14, 15). However, an investigation of the prevalence of harmful health and safety miscon-

[1] This study was made in partial fulfillment of the requirements for the degree of Doctor of Health and Safety in the School of Health, Physical Education, and Recreation, Indiana University, Bloomington, Indiana, June 1957. The test may be obtained from the author in mimeographed form. The cost is 25 cents for each form and 10 cents for the manual, to cover duplicating and mailing costs.

ceptions by Dzenowagis and Irwin (5) produced an instrument designed specifically for use among fifth- and sixth -grade children. A health knowledge test for college freshmen was developed for use as a pretest by Bridges (3). Studies by Mayshark (10) and Myers (11) concerning health and safety attitude scales indicated the feasibility of developing valid and reliable instruments for use with a single grade level.

Nearly all of the investigators employed the multiple choice, best-answer type test item, with curricular validity most commonly based on the content of textbooks and courses of study. A few studies clearly indicated the method of statistical treatment of data to determine item validity, using one of three techniques: the Votaw curve (3), Flanagan Indices of Discrimination (5, 7), or computing the critical ratio (10, 11).

Kilander (7) obtained reliability coefficients of .88 and .86 for two test forms using the corrected split-halves method. Dzenowagis and Irwin (5), using the Kuder-Richardson formula 20, found the reliability coefficients for five forms used in their investigation to range from .74 to .82.

Procedures

Health knowledge includes the understanding and application of health concepts as well as the retention of health facts. For this reason, the multiple choice, best-answer type of test item was employed because of its adaptability to the measurement of higher mental processes and to minimize the effect of guessing and response sets. Each test item was written as an incomplete, declarative statement with four alternatives. A favorable balance of test items concerning the measurement of fact and understanding was maintained in each final test form.

Development of Preliminary Test Forms. The first step was to determine the general areas of health knowledge appropriate to the seventh grade and the emphasis to be given each area. This procedure required the determination of recognized authority concerning health subject matter at the seventh-grade level. It was decided that the authors of several widely used seventh-grade health textbooks would give broad representation to professional thought in the field and constitute a jury of experts larger than the minimum usually considered acceptable. Further, it was felt that the authors' written works would allow a more accurate judgment with greater freedom from bias than would result from personally contacting a similarly select group by questionnaire. As a result, seven widely used health textbooks were selected for the purpose of establishing curricular validity (see Appendix).

Ludwig's investigation (9) provided a sound basis for determining the appropriate areas of health knowledge and the emphasis assigned to each by the textbook authors. On this basis, a table of specifications for the test was formulated to include 14 topics in five major areas of health knowledge, each weighted in accord with the findings of the textbook analysis. This was done to provide for a balanced sampling of the health knowledge that seventh-grade pupils should possess. The proportion of emphasis to be devoted to

each major area of health information was found to be as follows: Personal Health, 30.9 percent; Nutrition, 24.1 percent; Diseases, 22.0 percent; Environmental Health, 15.7 percent; and Mental Health, 7.2 percent.

Items of health information suitable to test item construction were listed by area and topic, and by subtopic when appropriate, in order of frequency of occurrence in textbooks. Working within one area at a time, a total of 216 test items was developed in accord with the table of specifications. The following criteria were used as guides in item formulation:

1. Vocabulary burden appropriate to the seventh grade as attested by Thorndike and Lorge (17).
2. Authenticity of information tested corroborated by appropriate sources.
3. The stem of each item a concise, declarative statement, meaningful in itself, to imply a direct question.
4. Varying degrees of homogeneity of distractors to increase or decrease item difficulty consistent with the comprehension level of seventh-grade pupils.
5. Avoidance of clues and obvious, ambiguous, or trick items.

Each completed item was placed on an individual file card with appropriate information about the item. All items were then submitted to selected faculty members and doctoral candidates in the area of health education for constructive criticism and suggestions for revision.

The cards bearing test items were then arranged by topic within each area. Working through one area at a time, items were randomly assigned to three preliminary test forms of 72 items each, according to the table of specifications. Preliminary test forms A, B, and C were mimeographed in booklet form for administration.

Refinement of the Test. The investigator personally administered the preliminary test forms to 1196 seventh-grade pupils in six public schools in Indiana cities of the third class (population 20,000-35,000). Forms A, B, and C were distributed alternately throughout each group of pupils tested. Each examinee was provided an International Business Machines answer sheet and an electrographic pencil. Test directions were explained with the aid of blackboard illustrations using sample test items. No time limit for completion of the test was imposed.

The reliability coefficient, determined by the Kuder-Richardson formula as presented by Froelich (6), was found to be .78 for Form A, .73 for Form B, and .81 for Form C.

An item analysis chart was developed to facilitate the process of determining acceptable test items according to the following criteria:

1. The item must discriminate between the upper and lower 27 percent at, or beyond, the 1 percent level of confidence.
2. Item difficulty must be within the range of 10 to 90 percent.
3. Each distractor must function in 3 or more percent of the cases.

The Votaw curve technique (18) was used to determine item validity according to the criterion for discriminating power of items. Since the Votaw formula employs the 5 percent level, the value of K was changed from three probable errors to 3.82 probable errors to modify the curve to the

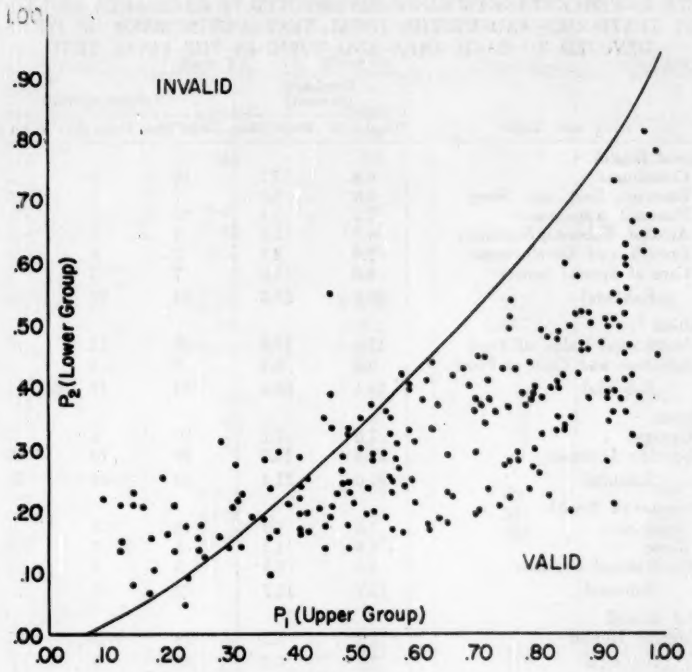

FIGURE I. The Votaw Curve and the location of experimental test items. K is 3.82 P.E. N is 102.

1 percent level. The plotting points were then calculated and the curve drawn. The curves for all three test forms coincided when plotted on the graph since the value of N was practically identical for Forms A ($N = 102$), B ($N = 102$), and C ($N = 103$). The position of each test item was then plotted on the Votaw graph according to the proportion of upper and lower groups answering the item correctly, as shown in Figure I. A total of 176 items met the criterion for item validity.

The difficulty of each item was found by computing the percentage of examinees answering the item correctly. The functioning of distractors was determined by finding the percentage of examinees selecting each option. Of the 176 valid items, 13 failed to meet the criteria for item difficulty and functioning of distractors, leaving a total of 163 acceptable items. A count of acceptable items revealed a sufficient number in each area and topic to meet the table of specifications for the final test forms. Selected items were assigned to two final test forms of 70 items each, designated FA and FB, with

TABLE 1.—PERCENTAGE OF EMPHASIS DEVOTED TO EACH AREA AND TOPIC BY TEXTBOOKS AND BY THE TOTAL TEST AND NUMBER OF ITEMS DEVOTED TO EACH AREA AND TOPIC IN THE FINAL TEST

Area and Topic	Emphasis (percent)		Number of Items		
	Textbooks	Total Test	Total Test	Form FA	Form FB
Personal Health					
Cleanliness	6.8	7.1	10	5	5
Exercise, Rest, and Sleep	4.8	5.0	7	3	4
Personal Appearance	7.1	7.1	10	5	5
Alcohol, Tobacco, Narcotics	4.7	5.0	7	4	3
Growth and Development	2.5	2.2	3	2	1
Care of Special Senses	5.0	5.0	7	3	4
Sub-total	30.9	31.4	44	22	22
Nutrition					
Nutritional Value of Food	17.6	17.8	25	13	12
Selection and Care of Food	6.5	6.4	9	4	5
Sub-total	24.1	24.2	34	17	17
Diseases					
General	7.0	7.1	10	5	5
Specific Diseases	15.0	14.3	20	10	10
Sub-total	22.0	21.4	30	15	15
Environmental Health					
Community	7.8	7.9	11	5	6
Home	4.4	4.3	6	3	3
Professional Services	3.5	3.5	5	3	2
Sub-total	15.7	15.7	22	11	11
Mental Health					
Mental Health	7.2	7.2	10	5	5
Sub-total	7.2	7.2	10	5	5
Total	99.9	99.9	140	70	70

strict adherence to the table of specifications as shown in Table 1. Test form FA is given in full in the Appendix.

Equivalence of Forms. The necessary test construction procedures for securing closely equivalent final test forms were carefully followed throughout the study. These procedures included: (a) experimental trial of a large number of items, (b) strict adherence to the table of specifications, and (c) standardization of the type of test item, length of the test, and the procedures and criteria for item refinement and selection. In addition, an attempt was made to build optimum equivalence into the two final forms by equating the order of item difficulty, mean test difficulty, and content.

Mean test difficulty was found to be 50.85 percent for Form FA and 50.52 percent for Form FB.

Administration of the Final Test. The final test forms were administered by classroom teachers to a total of 978 seventh-grade pupils in 35 randomly selected public schools in Indiana during regularly scheduled class periods. Of the 978 pupils, 304 were given both Form FA and Form FB.

TABLE 2.—STATISTICAL ANALYSIS OF THE RESULTS OF THE ADMINISTRATION OF TEST FORMS FA AND FB

Statistic	Form FA	Form FB	Difference	Critical ratio
Number				
Boys	279	264		
Girls	206	229		
Total	485	493		
Range				
Boys	8-61	6-63		
Girls	13-62	11-63		
Total	8-62	6-63		
Mean				
Boys	39.495	38.678	.817	1.005
Girls	40.456	42.131	1.675	1.754
Total	39.903	40.282	.379	.610
Median				
Boys	41	39	2	2.051
Girls	41	42	1	.873
Total	41	40	1	1.340
Standard Deviation				
Boys	10.369	9.783	.586	.916
Girls	9.084	9.408	.324	.431
Total	9.662	9.764	.102	.208
Reliability Coefficient (By Kuder-Richardson)				
Boys	.853	.831	.022	1.170
Girls	.805	.822	.017	.650
Total	.828	.828	.000	.000
Reliability Coefficient (By corrected split halves)	.865	.875	.010	.645

Test Manual. Upon completion of the analysis of the test results, a manual was developed to accompany the test. Information presented in the manual is concerned with the nature of the test, content, validity and reliability, general directions for the tester, the test key, norms, and the suggested raw score limits for assigning qualitative rating to pupil achievement.

Analysis of Final Test Data

Table 2 presents a statistical summary of the results of the administration of test forms FA and FB.

Examination of Table 2 indicates the comparability of score distributions for Form FA and Form FB. No real difference has been demonstrated in the central tendency or variability of score distributions, or in the reliability coefficients computed by two methods for each form.

The coefficient of correlation (Pearson r) between the scores made on the two forms by 304 seventh-grade pupils was found to be .823 ± .0186. Evidence concerning the existence of a real difference in the health knowledge of boys and girls as measured by this test was inconclusive.

Conclusions

The following conclusions were drawn from the study:

1. Forms FA and FB are valid and reliable instruments for measuring the health knowledge of seventh-grade pupils.
2. Forms FA and FB constitute equivalent forms and may be used interchangeably.
3. The test is sufficiently easy to administer and interpret to permit its effective, practical use by classroom teachers.
4. The test provides a means of appraising the curricular content of seventh-grade health instruction.

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Appendix A

SEVENTH GRADE HEALTH TEXTBOOKS

BROWNELL, CLIFFORD LEE; EVANS, RUTH; and HOBSON, LAWRENCE B. *About Your Health.* A B C Health Series. New York: American Book Co., 1955. 320 p.

BURKARD, WILLIAM E.; CHAMBERS, RAYMOND L.; and MARONEY, FREDERICK W. *You and Your Health.* Health-Happiness-Success Series. Chicago: Lyons & Carnahan, 1953. 319 p.

CHARTERS, W. W.; SMILEY, DEAN F.; and STRANG, RUTH M. *Growing Up Healthily.* Second revised edition. Your Health and Growth Series. New York: Macmillan Co., 1955. 302 p.

JONES, EDWINA; MORGAN , EDNA; and LANDIS, PAUL E. *For Healthful Living.* The Road to Health Series. New York: Laidlaw Brothers, 1954. 320 p.

O'KEEFE, PATTRIC RUTH, and MAXWELL, CYRUS H. *Adventures in Living.* Winston Health Series, Philadelphia: The John C. Winston Co., 1954. 214 p.

SHACTER, HELEN; JENKINS, GLADYS GARDNER; and BAUER, W. W. *You're Growing Up.* Health and Personal Development Series. Chicago: Scott, Foresman & Co., 1954. 320 p.

WILCOX, CHARLOTTE E., and BOLTON, WILLIAM. *Health Days.* Health Action Series. Chicago: Beckley-Cardy Co., 1956. 320 p.

Appendix B

HEALTH KNOWLEDGE TEST, Form FA

In the directions, the mechanics of using the answer sheet are explained in full. The students are instructed to read each statement carefully and then to select one answer which best completes the statement. They are told to try to answer each question but to avoid wild guessing.

1. Before fresh fruits and vegetables are cooked (1) wash them thoroughly, (2) soak them in cold water, (3) add soda to the water, (4) prepare them well ahead of cooking time.

2. If you have difficulty in going to sleep at night (1) keep a regular bedtime hour, (2) watch television until you become sleepy, (3) stay up to do your homework, (4) play an exciting game after supper.

3. To keep the hair soft and glossy (1) use a vinegar rinse after washing, (2) apply hair dressing every morning, (3) do not wear a hat or cap, (4) brush it several times daily.

4. The Salk vaccine was recently developed to give immunity against (1) colds, (2) polio, (3) tuberculosis, (4) rheumatic fever.

5. The number of calories a person needs each day (1) is the same for people of the same age, (2) remains the same once one is grown up, (3) is greater for fat people, (4) varies with age, sex and activity.

6. If your city water supply is made unsafe by floods (1) the water can not be used in homes, (2) do not use the water for the laundry, (3) boil all water used for drinking and cooking, (4) use softened water for drinking and cooking.

7. To be well dressed, select clothing which is (1) suitable for the occasion, (2) expensive in appearance, (3) the latest style, (4) just like the other students wear.

8. Medicine which contains cocaine is to be used only (1) under a doctor's directions, (2) in case of surgical operation, (3) when one has severe pain, (4) by grown-up persons.

9. A health agency which is supported by taxes is the (1) National Tuberculosis Association, (2) American Cancer Society, (3) Public Health Service, (4) American Heart Association.

10. During the 'teens, physical growth occurs at a rate which is (1) continuous and even, (2) the same for boys and girls, (3) the same for all parts of the body, (4) different for different persons.

11. Vigorous exercise benefits the person so long as (1) energy is restored by sleep and rest, (2) the activity is enjoyable, (3) one does not get tired, (4) it is done out of doors.

12. If tears do not remove an irritating object from the eye (1) rub the eye gently, (2) rub the opposite eye gently, (3) remove it with dry cotton on a toothpick, (4) consult a doctor or nurse.

13. Natural immunity to disease is strengthened by (1) avoiding vigorous exercise, (2) taking sulfa drugs, (3) good health practices, (4) using a tonic for the blood.

14. If you have difficulty with arithmetic (1) get extra help and do the best you can, (2) try to do perfect work and get the highest grade, (3) compare yourself with those who get high grades, (4) let it go and do something else.

15. Iron is needed by the body for the manufacture of (1) red blood cells, (2) white blood cells, (3) thyroxin, (4) lymph.

16. When we refer to the Basic 7, we are talking about (1) rules for preparing dinner, (2) the body's needs for minerals, (3) the "B" complex vitamins, (4) food needs in the daily diet.

17. When you have made a foolish mistake (1) pay no attention to it, (2) make up a reasonable excuse for the mistake, (3) try to learn by having made the mistake, (4) avoid trying such a task another time.

18. How people will feel about you depends upon (1) your social position, (2) how much education you have, (3) how smart you are, (4) what you are and what you do.

19. To keep flies from getting into the home (1) use yellow lights above the entrances, (2) spray doors and windows with fly spray, (3) put screens on all doors and windows, (4) keep the windows closed at all times.

20. School health examinations of pupils are made by a physician (1) to give treatment to pupils who are ill, (2) to discover and correct health defects, (3) to gather figures for public health records, (4) only when an epidemic of disease exists.

21. In preparing a thermometer to take mouth temperature (1) test it in hot water, (2) clean it with pure water, (3) hold the bulb by your finger tips, (4) shake it until it is 2 or 3 degrees below normal.

22. Personal appearance is improved when the hair is worn in a style that is (1) easy to care for, (2) popular, (3) becoming to the face, (4) new and different.

23. The most effective method of controlling tuberculosis is (1) immunization while one is healthy, (2) watching for symptoms of the disease, (3) taking penicillin after being exposed, (4) early discovery and treatment.

24. Garbage collected by the city is properly disposed of by (1) putting it in city dumps, (2) spreading it on waste land, (3) burning it, (4) dumping it in the river.

25. When you have a cold, avoid middle ear infection by blowing the nose (1) gently with both nostrils open, (2) with only one nostril held closed, (3) quickly and hard, both nostrils open, (4) by holding the nostrils closed, then open.

26. A disease which is carried by the Anopheles mosquito is (1) polio, (2) typhus fever, (3) malaria, (4) Rocky Mountain spotted fever.

27. A recently developed miracle drug used to fight disease is (1) quinine, (2) penicillin, (3) aspirin, (4) morphine.

28. The effect on the body of the nicotine in tobacco smoke is to (1) enlarge the blood vessels, (2) make the heart beat too fast, (3) stimulate the taste buds, (4) make one work efficiently.

29. The characteristic which does more than anything else for a person's looks is (1) friendliness, (2) intelligence, (3) cheerfulness, (4) cleanliness.

30. A disease which can be passed from one person to another is classified as (1) chronic, (2) hereditary, (3) communicable, (4) allergic.

31. Allowing the body to assume a slumping position (1) relieves strain on the spine, (2) is most restful for the whole body, (3) makes one round shouldered, (4) indicates self-confidence.

32. Food handlers in public places are given medical examinations to (1) find out if they are strong enough to work, (2) be able to get social security benefits, (3) help prevent the spread of disease, (4) see if they have any physical defects.

33. To clean the teeth properly use (1) a loose grip on the toothbrush, (2) a paste containing gritty substances, (3) downward strokes of the brush on lower teeth, (4) a small toothbrush with firm bristles.

34. To help prevent eyestrain, arrange the light for reading so that it (1) reflects brightly from the page, (2) is close to the book, (3) falls from above the eyes, (4) is even with the level of the eyes.

35. Over-exercise or extreme amounts of work result in (1) more efficient muscles, (2) good physical condition, (3) lowered body resistance, (4) reducing weight safely.

36. The two chief body builders among the minerals in one's diet are (1) calcium and phosphorus, (2) iron and phosphorus, (3) iron and iodine, (4) calcium and iodine.

37. A teen-ager's mental health is improved by (1) avoiding responsibility whenever possible, (2) adjusting to his environment, (3) having his own way about everything, (4) letting his environment control his actions.

38. Minerals in the daily diet are used by the body to (1) make body heat, (2) increase the appetite, (3) regulate body functions, (4) balance high energy foods.

39. The principal reason why people become overweight is that (1) fatness is inherited, (2) good-natured people are usually fat, (3) the thyroid gland is very active, (4) they eat too much food of the energy group.

40. A disease which causes the lungs to become inflamed and thus interferes with breathing is (1) anemia, (2) hemophilia, (3) typhoid fever, (4) pneumonia.

41. The direct cause of tuberculosis is (1) a germ, (2) overwork and worry, (3) inherited, (4) not known.

42. A "quack" doctor is one who (1) has special powers to cure disease, (2) has no scientific training as a doctor, (3) uses scientific methods of treatment, (4) became a doctor through practical experience.

43. A disease in which certain cells in the body grow much faster than do normal cells is called (1) leprosy, (2) cancer, (3) cretinism, (4) adenoids.

44. The organ which is often damaged as a result of rheumatic fever is the (1) lung, (2) stomach, (3) liver, (4) heart.

45. To prevent goiters, the body needs small amounts of (1) calcium, (2) phosphorus, (3) iron, (4) iodine.

46. A person is mature in his emotions when he (1) has completed physical growth, (2) can accept reality, (3) does not become angry, (4) has no fears.

47. The tuberculin skin test is used to find out if a person has (1) ever been infected with tuberculosis, (2) been cured of tuberculosis, (3) immunity to tuberculosis, (4) inherited tuberculosis from his parents.

48. Public health nursing services in the home are provided by (1) hospitals and clinics, (2) voluntary health agencies, (3) health insurance companies, (4) local health departments.

49. To save the vitamins in fresh green vegetables (1) cook them slowly in open vessels, (2) cook them in as little water as possible, (3) add a pinch of soda to the water, (4) raise them to the boiling temperature slowly.

50. Whether a person will be tall and slender or short and stocky depends first of all upon (1) the environment he lives in, (2) inherited physical characteristics, (3) the kinds of foods he eats, (4) his habits of posture.

51. Vitamin C in the daily diet helps to prevent (1) rickets, (2) scurvy, (3) night blindness, (4) beriberi.

52. The conditions which are favorable to the growth of disease germs are (1) warmth, moisture, and light, (2) warmth, moisture, and darkness, (3) warmth, dryness, and light, (4) warmth, dryness, and darkness.

53. When a person has once had rheumatic fever, he has (1) lasting immunity to rheumatic fever, (2) greater resistance to rheumatism, (3) become a carrier of the disease, (4) increased chances for further attacks.

54. When cutting the toenails, trim them (1) so that the end is rounded, (2) straight across, (3) with outer edges longer than the center, (4) to fit the end of the toe.

55. When you have bad breath which has its origin in the mouth (1) consult your dentist, (2) try a new kind of toothpaste, (3) use a gargle each morning, (4) chew gum regularly.

56. A food which has little protein value is (1) potatoes, (2) whole grain bread, (3) cheese, (4) eggs.

57. The appearance of the skin depends first of all upon (1) the kind of soap one uses, (2) the health of the whole body, (3) using cosmetics properly, (4) how often one bathes.

58. A person who eats properly, gets plenty of sleep, rest, and exercise will (1) have less resistance to colds, (2) develop immunity to colds, (3) be less susceptible to colds, (4) need no other precautions to avoid colds.

59. Disease germs injure the body by producing (1) antibodies, (2) antitoxins, (3) toxins, (4) serum.

60. To aid the thyroid gland in maintaining its proper function, use (1) iodized salt, (2) vitamin pills, (3) iron and yeast, (4) insulin.

61. A small amount of alcohol in the blood (1) increases physical skill, (2) helps one to work faster, (3) has no effect on one's actions, (4) causes more talking and laughing.

62. Cellulose, necessary for bulk in the diet, is found in (1) milk products, (2) meat fibers, (3) white rice, (4) whole grain cereals.

63. A lack of vitamin D in the diet of babies causes (1) anemia, (2) pellagra, (3) rickets, (4) scurvy.

64. A device used to test hearing is the (1) audiometer, (2) hearing aid, (3) radioscope, (4) sound meter.

65. Of the following foods, the richest source of vitamin B is (1) butter, (2) cantaloupe, (3) lean pork, (4) squash.

66. To provide air movement which will give best ventilation in sleeping rooms (1) depend upon the circulating fan in the furnace, (2) open windows from top and bottom, (3) open windows from the top, (4) open windows wide at the bottom.

67. Vitamin D is found in large amounts in (1) grapefruit, (2) fish liver oil, (3) fresh skim milk, (4) yellow vegetables.

68. A condition in which many pimples, whiteheads, and blackheads form in the skin is called (1) dermatitis, (2) allergy, (3) eczema, (4) acne.

69. A narcotic used chiefly by physicians for medical purposes is (1) heroin, (2) caffeine, (3) marijuana, (4) cocaine.

70. The richest source of proteins for growth and body repair is (1) animal products, (2) fruits, (3) vegetables, (4) cereals.

(Submitted 8/4/58)

A Comparison of Reaction and Movement Times of Women Athletes and Nonathletes

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Abstract

Scores for reaction time and movement time, as measured on an electronic apparatus, of 47 women athletes were compared with similar scores of 75 women nonathletes. The athletes were further studied by grouping them by sport specialties—tennis players, fencers, swimmers, and field hockey players.

It was concluded that women athletes are significantly faster than women nonathletes in speed of movement and reaction. Also, tennis players, swimmers, fencers, and field hockey players differ significantly in speed of movement, but they do not differ in reaction time. In addition, a statistically significant relationship was found between reaction and movement time.

THIS STUDY WAS DESIGNED primarily to compare the reaction time and arm movement time of selected women athletes with women nonathletes at Michigan State University.[1] Subproblems were (a) comparison of reaction and movement times among participants in four different types of sports—tennis, fencing, swimming, and field hockey, (b) correlation of reaction and movement time of each nonathlete with physical education achievement as measured by letter grade, (c) comparison of the reaction and movement time rank of individual athletes with their coach-assigned ability rank within a sport activity, (d) correlation of reaction with movement time.

Review of Literature

Burley (2), Hubbard (6), Keller (7), and Cureton (3) found reaction time of male athletes faster than that of nonathletes. The study by Beise and Peaseley (1) dealing with reaction time of skilled and unskilled women showed similar results. Pierson (9) discovered a significant difference between male fencers and nonfencers in speed of movement. Cureton (3) and Keller (7) in independent studies found that all sports do not require the same degree of quickness of body movement and that proficiency in athletics is related to the ability to move the body quickly. Rarick (10) concluded that speed of movement possessed by an individual with a high degree of motor ability cannot be increased to any appreciable extent. In independent

[1] Reaction time is defined as the interval between the excitation of a visual stimulus and the finger release of a reaction key (muscular response). Movement time is defined as the time taken to move the hand and arm a prescribed distance. Athlete, for purposes of this study, is defined as a female student who competed on an intercollegate basis: for the purposes of this study, a nonathlete is defined as a woman enrolled in a beginning tennis, fencing, or swimming class.

studies, Henry (4), Henry and Trafton (5), and Slater-Hammel (12) found reaction time and speed of movement to be uncorrelated.

Experimental Method

Apparatus. The apparatus used consisted of a response unit, stimulus unit, recording unit, and a stimulus-producing unit, which was a modification of that used by Pierson in his study of fencers (9: 11-16). The response unit consisted of a reaction key, electronic eye with accompanying light beam, and a card target. (See Figure I.) Reaction time and movement time were measured with this unit. The electronic eye with accompanying light beam was mounted directly behind and at a distance of 11 in. from the center of the reaction key. A 5 x 8 white card serving as the target was placed 2 in. behind the light beam of the electronic eye and approximately 13 in. from the center of the reaction key. The stimulus unit consisted of one yellow lamp used as the visual stimulus. It was placed directly behind and on the same plane as the response unit. Also, a preparatory set buzzer was placed 5 ft. from the response unit. The recording unit included two chronoscopes calibrated in .01-sec. units. Reaction time was recorded by one chronoscope which was actuated on the presentation of the visual stimulus and stopped upon the release of the reaction key. Holding down the reaction key closed the circuit, which was broken when the key was released. Movement time was recorded by the second chronoscope which was activated upon the release of the reaction key and stopped when the light beam of the electronic eye was broken. The stimulus-producing unit consisted of two switches which were held in the operator's left hand. One switch actuated the preparatory set buzzer while the second actuated the visual stimulus. Placement of this unit made its operation inaudible to the subjects.

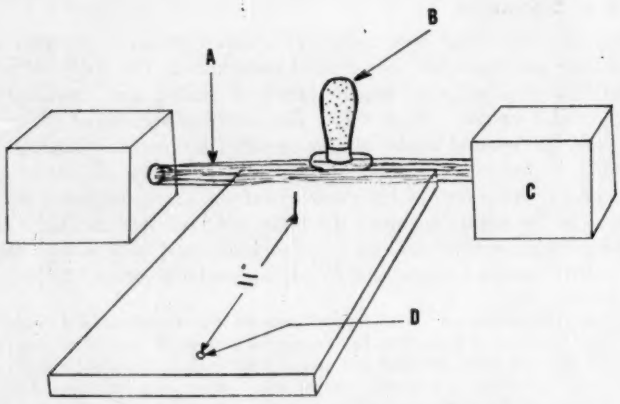

FIGURE I. Reaction and movement time apparatus.

Subjects. Data were collected at Michigan State University from 122 volunteer subjects. These subjects constituted two groups, the athletes and the nonathletes. The nonathletic group was comprised of 75 women, of whom 32 were enrolled in a beginning tennis class, 17 in a beginning fencing class, and 26 in a beginning swimming class. Of the 47 women in the athletic group, all were competing on an intercollegiate basis and included 8 tennis players, 7 fencers, 12 swimmers, and 20 field hockey players.

Procedure. The reaction time and movement time tests were administered during regularly scheduled class sessions during the last three weeks of the spring term of 1956. All data were obtained between the hours of 9:00 a.m. and 4:00 p.m. The stimulus and response units were placed on a standard office desk 7 ft. from the recording and stimulus-producing units. Arrangement of the apparatus made it possible to place the subject within full view of the operator at all times.

Each subject was tested individually. To facilitate the process, the subject and operator were isolated within the testing room. After the subject filled out a short personal data questionnaire, she assumed a comfortable position at the desk, facing the front of the stimulus and response units. She was then given verbal instructions which emphasized the "muscular response" (8). The starting position was standardized by directing each subject to hold down the reaction key with the middle fingers of her dominant hand, holding the elbow comfortably next to the body. To ensure the proper preparatory set, an electric buzzer was used to present an auditory signal prior to the presentation of the visual stimulus. On the appearance of the visual stimulus, the subject was instructed to move her hand from the reaction key directly forward toward the target through the beam of the electronic eye. Since the movement was 11 in. forward, other muscles besides those controlling the fingers were brought into play. This action constituted one complete trial. A careful demonstration of the desired response followed the verbal instruction. Thirty-five consecutive reaction time measures and 35 movement time measures were obtained from each subject. No rest periods were taken between trials. The time interval or foreperiod between the auditory signal and the visual stimulus was either 1, 2, 3, or 4 sec. (11). These time intervals were presented in a sequence which was randomly selected by drawing the numbers from a closed box. The sequence was the same for each subject. The complete testing procedures lasted a maximum of 10 min. for each subject. The data were recorded by the operator on the subject's questionnaire card.

Arithmetic means were computed for movement and reaction time scores of each subject. The difference in means for reaction and movement time between athletes and nonathletes was tested for significance by using the large sample t test.

Within the athletic group, analyses of variance with corresponding F test of significance were used to determine if the four sport groups were from a homogeneous or heterogeneous population. Rank-difference coefficients of

correlation were computed for each sport to measure the degree of association between reaction time and movement time ranks and coach-assigned ability rank.

For the nonathletes, analyses of variance by letter grade were computed for each sport.

Product-moment coefficients of correlation were computed to determine the relationship between reaction and movement time.

Results and Discussion

The last 20 trials of each subject were used to compute the individual means. Pierson found in dealing with 35 reaction and movement time trials that a practice curve existed through the first 15 trials (9: 87). The mean reaction and movement times for the athletes and nonathletes are shown in Table 1 together with the t and probability values. The difference between the athletes' and nonathletes' mean reaction time was statistically significant. Similar results were found regarding athletes' and nonathletes' mean movement times. The results of this study support the findings of Burley (2), Cureton (3), Hubbard (6), and Keller (7).

From the writer's observations, it appeared as though the athletes were motivated to a greater degree than the nonathletes. Perhaps they were more likely to treat this as a competitive situation. If this were a factor, it probably also applies in previously reported comparisons. On the other hand, it

TABLE 1.—MOVEMENT AND REACTION TIME MEANS, STANDARD DEVIATIONS, AND "T" SCORES OF ATHLETES AND NONATHLETES

Subject Groups		Movement Time				Reaction Time			
	N	M	σ	t	P	M	σ	t	P
Athletes	47	.275	.0255	4.85	less than .01	.248	.0266	5.04	less than .01
Nonathletes	75	.298	.0262			.273	.0276		

TABLE 2.—MOVEMENT AND REACTION TIME MEANS, STANDARD DEVIATIONS, AND "T" SCORES OF ATHLETES AND VARIOUS SPORTS

	N	M	σ	t		
				Fencers	Tennis	Swimmers
Movement Time						
Field Hockey	20	.265	.0266	.991	.756	2.70[a]
Fencers	7	.275	.0193		.038	1.30
Tennis	8	.276	.0257			1.78
Swimmers	12	.290	.0233			
Reaction Time[b]						
Field Hockey	20	.251	.0284			
Fencers	7	.240	.0331			
Tennis	8	.236	.0146			
Swimmers	12	.257	.0197			

[a]Statistically significant, P=0.01.
[b]t's were not computed for reaction time since the F was not significant.

TABLE 3.—CORRELATION BETWEEN COACH-ASSIGNED ABILITY RANK AND RANK IN MOVEMENT AND REACTION TIME

Sport	N	Rhos[a]	
		Movement Time	Reaction Time
Tennis	8	—.0952	.3095
Swimming	12	—.4340	—.0909
Fencing	7	.5358	—.3541
Field Hockey	20	.2357	.2781

[a]None of these rhos was significant at the 5 percent level.

is feasible that athletes excel in speed of reaction and movement because of an unknown innate quality which is responsible to some extent for their success in athletics. In dealing with reaction time, another possibility suggests that athletic excellence can be attributed to physical training. There is evidence to support this hypothesis (6) as well as evidence to repudiate it (1).

Within the athletic group, analysis of variance with corresponding F score of only 1.327 indicated that there was no evidence that the tennis, fencing, swimming, and field hockey groups were not from a homogeneous population insofar as reaction time was concerned. Cureton (3) found that swimmers, as compared to various champion athletes, demonstrated slowest total body reaction time. Of the four sport groups tested in this study, it should be noted that the swimmers vary widely from the other three, with the slowest reaction times.

In contrast with the reaction time results by sport, the movement time F of 15.3 was significant with a probability of less than 0.01, indicating that the four sport groups were not from the same population. The means, standard deviations, and t values for the various sports groups are shown in Table 2. It appears that the type of physical activity is more closely related to speed of movement than reaction time. Field hockey, tennis, and fencing require quick change of direction, "start and stop" types of activities. In contrast, swimming requires entirely different types of movement.

The results of the rank-difference coefficients of correlation for the athletes are presented in Table 3. These correlations between rank in movement time, rank in reaction time, and coach-assigned ability ranks within the tennis, swimming, fencing, and field hockey groups were not significant.

The results of both movement and reaction time rank-difference correlations indicated that individual scores and ability within a particular sport were not correlated. The ranking by the coach was subjective, and this could have contributed to the low correlation. Also, the small number of subjects makes it difficult to show statistical significance.

Among the nonathletes, none of the F ratios in the six analyses of variance by letter grade for each course were significant. In five of the comparisons, the variation within the letter grades was greater than the variation between letter grades; therefore, an F could not be computed. In analyzing the reaction time and movement time data, letter grades affected by student

absences were excluded. This necessitated the use of a smaller number within the swimming group. Within the three sports, there was no evidence indicating a trend toward the "A" students being faster than the "B," the "B" faster than the "C," or the "C" faster than the "D-F" group.

When dealing with women on the college level, letter grades are often based upon measures other than performance. Therefore, it is not surprising that the difference was statistically insignificant. The interest of the student enrolled in an activity class of the type tested plays a large role in determining her final grade as well as affecting her performance and skill within the class. It is natural to assume that letter grades (due to their subjectivity) would vary to a greater degree than reaction time or movement time.

To determine the relationship between individual reaction time and movement times, correlation coefficients were computed for the athletes and nonathletes. The resulting correlations for the athletes and nonathletes were 0.27 (P = between 0.05 and 0.01), and 0.25 ($P = 0.05$) respectively. These correlations were low but statistically significant. Although these findings would tend to contradict the results of Henry (4), Henry and Trafton (5), and Slater-Hammel (12), the possibility exists that the release of the reaction key may have been affected by the muscles used in moving the arm.[2]

Conclusions

From the statistical analysis of the data, the following conclusions were drawn:

1. Women athletes are significantly faster than women nonathletes in speed of arm movement and reaction time.
2. Neither reaction time nor movement time is correlated with coach-assigned ability positions in tennis, swimming, fencing, or field hockey.
3. Within the athletic group, tennis players, swimmers, fencers, and field hockey players do not differ significantly in reaction time.
4. Within the athletic group, a trend indicated that the swimmers were the slowest movers; no difference was demonstrated between the field hockey, fencing, and tennis groups.
5. Movement and reaction times of nonathletes taking courses in tennis, swimming, and fencing are unrelated to physical education achievement as measured by letter grade in these courses.
6. A statistically significant but low correlation exists between reaction time and movement time. This was true among both the athletes and nonathletes.

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Physical Performance of Children Taught by Special Teachers and by Classroom Teachers

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Abstract

Results of the AAHPER Physical Fitness Test given to children in two types of teaching situations were compared. Girls having special teachers were found to have scored significantly better in 14 of 35 classification events, and boys, in 20. The differences found indicate that, as far as the measured performances are concerned, a concerted effort to provide special teachers of physical education for grades 5 through 8 seems well worthwhile.

AREA CONFERENCES in a midwestern state have revealed doubts of elementary school administrators about the value of physical education as conducted in the small schools. Since, with very few exceptions, physical education in this area is taught by classroom teachers, it has frequently been suggested that professionally prepared teachers of physical education be employed. Some schools can do this. In other schools, the administrators consider it financially impossible to increase the number of teachers. The possibility of reorganization of the school to permit a teaching position to be devoted to physical education has been considered in several schools where this could be carried out. At this point the administrators have expressed a desire for evidence of accomplishment when special teachers are assigned to a concentrated program of physical education classes. To study the problem completely would necessitate obtaining evidence of progress toward all goals of physical education. However, investigation of accomplishment in physical performance, a unique goal of physical education, seemed an acceptable way to approach the problem.

Purpose

This study was conducted to compare the physical performance scores made by elementary school children who have special teachers of physical education with those of children in a similar school where physical education is taught by the regular classroom teachers. In this study, special teachers are former classroom teachers who have taken over the teaching of concentrated programs of physical education. They are not professionally prepared physical education teachers.

Procedures

The schools were selected from 31 state counties which have common industrial and socio-economic problems. Basic information was obtained from the state school directory for 1957-58. The school in which physical education is taught by classroom teachers, Cl School, was randomly selected from all elementary schools with an enrollment of less than 500. Since only a few of these elementary schools have special teachers of physical education, the school selected to represent this group, Sp School, is one in which all other factors most nearly parallel those of Cl School. It has an enrollment of less than 500. The two schools are located in towns of similar size and economic level, in essentially rural areas. In both schools all students are required to take physical education daily. Indoor space and facilities of the two schools are similar, each having one good-sized gymnasium with no special equipment or apparatus. The outdoor play areas are of similar size and surfacing, and the schools have similar playground apparatus. The programs of activities in both schools are based on the state bulletins of physical education for elementary schools. They include sport skills, low organized games, lead-up games, self-testing activities, and rhythmic activities.

In the school which has special teachers, a man and a woman have been assigned by the school administrator to teach only physical and health education classes. Neither of the special teachers is a graduate of a physical education major curriculum but each is interested in physical education and each has taken a few courses besides the required service classes.

Boys and girls of grades 5 through 8 were included in the study. The AAHPER Physical Fitness Test established in 1957 was used, the aquatic test item being omitted because there were no swimming pools. The test included sit-ups, pull-ups (boys in grades 7 and 8), modified pull-ups (boys in grades 5 and 6 and all girls), shuttle race, standing broad jump, softball throw for distance, 50-yd. dash, and 600-yd. run-walk. All tests were administered by the writer.

Date of birth, height, and weight were obtained in order that the influence of these factors could be considered when comparing the scores. Using the technique devised by Neilson and Cozens (2), the children's records were classified into A, B, C, D, E, F, G, and H groups. The group in which a child belongs was found by locating his age, height, and weight on the chart. Exponents were given for each of these factors and their sum provided the basis for the classification. Because of the few subjects in the extreme classifications, groups A and B were combined as also were F, G, and H. Therefore, five classifications were used in this study.

Presentation of the Data

The mean scores made by each age-height-weight group of boys in the two schools are presented in Table 1. The results for both the modified pull-up test, taken by fifth- and sixth-grade boys, and the regular pull-ups performed

by the seventh- and eighth-grade boys are found in Part A of Table 1. Parts B, C, D, E, F, and G of Table 1, respectively, present the results of the sit-up test, the shuttle race, the 50-yd. dash, the softball throw for distance, the standing broad jump, and the 600-yd. run-walk. For each item, the t-test was used to determine the significance of the differences between the mean scores made by the various student groups in the two schools. The 5 percent level of confidence was accepted as identifying a statistically significant difference.

TABLE 1.—COMPARISON OF PHYSICAL FITNESS TEST SCORES MADE BY BOYS IN PHYSICAL EDUCATION CLASSES TAUGHT BY SPECIAL TEACHERS AND BY CLASSROOM TEACHERS.

Groups	Cl. N	Cl. Mean	Sp. N	Sp. Mean	Diff.	S. E. Diff.	t	Sig. Level
	Part A. Modified Pull-Up Test (Maximum 40 repetitions)							
A & B	17	36.1	17	40.0	3.9	1.828	2.1	.05
C	9	35.8	14	40.0	4.2	.8249	5.1	.01
D	5	33.8	9	40.0	6.2	2.7362	2.3	.05
			Pull-Up (Not modified)					
E	9	1.4	9	2.3	.9	.9876	.9	.40
F G H	11	.9	23	3.2	2.3	.8712	2.6	.01
	Part B. Sit-Up Test (Maximum 100)							
A & B	17	32.7	15	67.1	34.4	10.1241	3.4	.01
C	14	50.6	18	64.0	13.4	9.7912	1.4	.20
D	12	35.8	12	50.0	14.2	8.6746	1.6	.20
E	12	36.5	15	56.1	19.6	3.1202	6.3	.01
F G H	10	31.0	26	41.0	10.0	9.431	1.1	.30
	Part C. Shuttle Race							
A & B	17	11.7	15	10.5	1.2	.2320	5.2	.01
C	14	11.0	18	10.3	.7	.1849	4.2	.01
D	12	11.5	12	10.2	1.3	.2695	4.7	.01
E	12	11.2	15	10.3	.9	.3683	2.4	.05
F G H	9	11.2	26	10.1	1.1	.4380	2.4	.02
	Part D. 50-Yard Dash							
A & B	17	8.9	15	8.5	.4	.2633	1.4	.20
C	13	8.1	18	8.1	.0	—	—	—
D	11	8.3	13	8.1	.2	.3198	.7	.50
E	12	7.9	15	8.3	.4	.3931	1.0	.40
F G H	9	8.0	27	8.2	.2	.3502	.7	.60
	Part E. Throw							
A & B	17	88.5	15	102.5	14.0	5.6416	2.5	.02
C	13	107.5	18	118.1	10.6	7.3688	1.4	.20
D	12	106.7	12	123.0	16.3	7.6272	2.1	.05
E	12	119.7	15	122.0	2.3	9.103	.3	.80
F G H	10	124.5	26	138.9	14.4	9.7560	1.5	.20

	Part F. Standing Broad Jump							
A & B	17	52.3	15	68.1	15.8	2.1815	7.2	.01
C	14	59.6	18	73.6	14.0	2.5464	5.5	.01
D	12	57.0	12	75.4	18.4	3.3453	5.5	.01
E	12	63.0	15	71.0	8.0	4.996	1.6	.20
F G H	9	63.0	22	75.6	12.6	4.1748	3.0	.01
	Part G. 600-Yard Run-Walk							
A & B	15	164.5	15	149.8	14.7	9.3802	1.6	.20
C	12	160.2	18	131.7	28.5	5.9316	4.8	.01
D	11	155.8	12	136.6	19.2	10.5552	1.8	.10
E	12	163.1	15	141.2	21.9	7.1652	3.1	.01
F G H	9	178.4	26	142.1	36.3	10.4244	3.5	.01

Comparisons for Boys

In the boys' pull-up test, the higher mean scores were obtained by all groups of the Sp School. For four of these groups the differences were statistically significant.

In the sit-up test, all Sp groups had higher mean scores than the corresponding Cl groups. The differences were statistically significant for two of the groups.

For the shuttle race, the mean scores for the Sp groups were all better than the corresponding scores for the Cl groups. All differences were statistically significant.

In the 50-yd. dash, two groups in the Sp School had mean scores which were better than those made by corresponding groups of the Cl School. In two of the remaining groups, the Cl School had the better mean scores. None of the differences was statistically significant.

In the throwing test, the mean scores of all Sp groups exceeded those of corresponding Cl groups. For two groups the differences were statistically significant.

In the standing broad jump, all Sp groups had higher mean scores than were obtained by the Cl groups. Four of the five differences were statistically significant.

In the 600-yd. run-walk, the better mean scores were obtained by all groups of the Sp School. For three of these groups the differences were statistically significant.

Discussion

Boys taught by special teachers exceeded the performance of comparable boys taught by classroom teachers in 31 of the 35 group-classification events. The differences were statistically significant for 20 of the comparisons.

For the boys, the greatest differences between the two schools were found in the shuttle race, the standing broad jump, and the 600-yd. run-walk. Since the performance of these tests requires leg strength and power, agility, and cardio-vascular endurance, it would seem that boys taught by special teachers showed greater development of these qualities than did boys taught by classroom teachers.

Comparisons for Girls

In the pull-up test for girls, all Sp groups had higher mean scores than the corresponding groups of the Cl School. For two of these groups the differences were statistically significant.

In the girls' sit-up test, all mean scores of the Cl groups surpassed those of the Sp groups. None of the differences between the mean scores of the two schools was statistically significant.

TABLE 2.—COMPARISON OF PHYSICAL FITNESS TEST SCORES MADE BY GIRLS IN PHYSICAL EDUCATION CLASSES TAUGHT BY SPECIAL TEACHERS AND BY CLASSROOM TEACHERS.

Groups	Cl. N	Cl. Mean	Sp. N	Sp. Mean	Diff.	S. E. Diff.	t	Sig. Level
	Part A. Pull-Ups (Maximum 40 repetitions)							
A & B	11	34.5	15	37.2	2.7	2.3939	1.1	.30
C	17	27.9	22	34.8	6.9	2.4824	2.8	.01
D	18	28.7	20	32.5	3.8	3.6170	1.0	.30
E	9	30.4	24	33.4	3.0	3.3380	.9	.40
F G H	14	24.1	29	35.3	11.2	3.0968	3.6	.01
	Part B. Sit-Ups (Maximum 50)							
A & B	11	19.4	17	15.2	4.2	4.249	1.0	.40
C	17	24.2	17	21.5	2.7	2.9815	.9	.40
D	18	21.3	20	17.2	4.1	3.8940	1.1	.30
E	10	20.9	24	17.6	3.3	5.2117	.6	.60
F G H	14	16.9	29	16.8	.1	3.4082	—	—
	Part C. Shuttle Race							
A & B	11	12.0	18	11.4	.6	.3824	1.5	.20
C	17	12.0	22	11.3	.7	.3196	2.4	.02
D	18	12.1	20	11.0	1.1	.2180	4.9	.01
E	10	12.3	24	11.2	1.1	.2779	3.6	.01
F G H	14	12.2	29	11.1	1.1	.2950	3.6	.01
	Part D. 50-Yard Dash							
A & B	11	9.3	17	8.8	.5	.3172	1.6	.20
C	16	8.9	23	8.5	.4	.2369	1.5	.20
D	18	8.8	20	8.3	.5	.2643	1.7	.10
E	10	9.2	22	8.3	.9	.3022	3.1	.01
F G H	13	8.8	29	8.4	.4	.2493	2.0	.05

	Part E. Throw							
A & B	11	42.8	18	45.5	2.7	4.3564	.6	.60
C	17	45.2	23	52.7	7.5	5.3132	1.4	.20
D	18	52.1	20	59.1	7.0	5.6542	1.2	.30
E	10	58.1	22	67.9	9.8	7.0016	1.4	.20
F G H	13	72.5	29	73.8	1.3	7.6325	.2	.90
	Part F. Standing Broad Jump							
A & B	11	49.7	18	57.3	7.6	2.5330	3.0	.01
C	17	50.2	23	59.3	9.1	2.2963	3.9	.01
D	17	51.5	20	61.9	10.4	2.3815	4.4	.01
E	18	58.7	22	63.1	4.4	3.1345	1.4	.20
F G H	16	54.2	29	64.4	10.2	2.5053	4.1	.01
	Part G. 600-Yard Run-Walk							
A & B	10	204.9	18	187.3	17.6	11.4048	1.5	.20
C	17	203.1	23	189.6	13.5	10.6822	1.3	.30
D	17	189.9	20	173.0	16.9	7.2441	2.3	.02
E	9	189.4	22	184.0	5.4	9.9308	.5	.60
F G H	14	191.7	29	180.2	11.5	4.8071	2.4	.02

In the shuttle race, the better mean scores were obtained by all groups of the Sp School. For four of these groups the differences were statistically significant.

In the 50-yd. dash, mean scores of all the Sp groups were better than those of the Cl groups. Two of these differences were statistically significant.

Although all Sp groups surpassed the Cl groups in mean scores on the throwing test, no statistically significant differences occurred.

In the standing broad jump, the mean scores of all Sp groups exceeded those of the Cl groups. Four of these differences were statistically singnificant.

In the 600-yd. run-walk, mean scores of all the Sp groups were better than the mean scores of corresponding Cl groups. Two of these differences were statistically significant.

Discussion

Girls taught by special teachers exceeded the performance of comparable girls taught by classroom teachers in 30 of the 35 group-classification events. The differences were statistically significant for 14 of the comparisons.

The greatest number of statistically significant differences between the performance by girls in the two schools occurred in the shuttle race and the standing broad jump. This would seem to indicate that girls taught by special teachers developed greater agility, leg strength, and power than did girls taught by classroom teachers.

The fact that these differences occurred when teachers were given time to concentrate on teaching physical education brings up the question of what could be attained in classes taught by professionally prepared teachers of physical education.

Conclusions

On the basis of these findings, it may be concluded that children taught by special teachers of physical education exhibit a higher level of physical performance than those taught by classroom teachers.

Recommendations

1. Elementary schools in which physical education is taught by classroom teachers should make a concerted or renewed effort to provide special teachers of physical education.
2. If an additional teacher or teachers cannot be employed, the possibility of reorganizing the school with one fewer classroom teacher and one special teacher of physical education should be thoroughly investigated.
3. A study should be conducted to ascertain the reactions of classroom teachers to two important aspects of such reorganization: the necessary increase in class size and the free period resulting for the classroom teacher, as well as the decrease in preparation.
4. A similar study should be conducted in which the special teachers are professionally prepared teachers of physical education.
5. A study should be conducted to ascertain differences in achievement of other goals of physical education in schools having classroom teachers of physical education and those having professionally prepared teachers of physical education.

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Notes and Comments

NOTES

A Method For Evaluating the Significance of Differences Observed in a Case Study

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IN RECENT YEARS, the single-subject case study has become increasingly popular as a research tool in physical education. Frequently, the scope of the data desired, a limited availability of subjects having particular qualities, and economy of test administration dictate at least a pilot investigation using the single-subject case study technique. Several examples (1, 2, 5, 6, 8) of this type of research are listed in the references. Such studies present inherent difficulties, however, if one wishes to evaluate the significance of the differences observed between test scores obtained before and after the introduction of an experimental factor, EF.

In a limited number of these investigations, two sets of data may be obtained for each variable by testing the subject several times in a relatively constant state both before and after the EF. Within each of these sets of data, the test scores may then be considered to be cases with the mean of the test scores representing an approximation to the subject's "true score" for the test item at that time. Under these circumstances, the standard t test may be used to evaluate the significance of the observed differences between means.

Unfortunately, in most studies this retesting procedure is unacceptable. In some instances, the process of retesting introduces a training or a learning factor. At other times, especially when data must be collected at the termination of exercise, a single measurement at a specified moment is all that is possible. Under conditions such as these where the number of cases, N, is limited to 1, the t test becomes useless. That is, regardless of the size of the observed difference, the value of t disappears since the standard error of the difference between means is infinite.

Comparison with Normal Distribution

In order to evaluate the significance of the differences observed when $N = 1$, it is necessary to compare the observed differences with the normal distribution of scores for the variable in question. The measure which is used most commonly to denote the dispersion of obtained scores around true scores is the standard error of estimate (3, p. 404),

$$S_e = \sigma_x \sqrt{1 - r_{12}},$$

where: σ_x is the standard deviation of raw scores, and
r_{12} is the coefficient of reliability based upon test-retest stability.

This statistic frequently is called the "standard error of measurement" or the "standard error of an obtained score." However, S_e is not quite a suitable measure for evaluating the significance of the difference between two single test scores. That is, when two observed values are being compared, each represents an estimate of a true score. The difference between an observed score and the corresponding true score is an error of measurement. Therefore, two errors of measurement are involved.

Gulliksen (4) describes an applicable statistic which is based upon theory similar to that used in the derivation of S_e, which he calls the "standard error of a difference for the case in which the two standard deviations are alike, S_d." This statistic was presented earlier by Kelley (7), who called it the "standard deviation of differences between scores on two similar forms."

Derivation of S_d

Before applying S_d to the case study technique, one should understand the basic concepts underlying its derivation. In summary, S_d is obtained as follows:

The difference between two raw scores, X_1 and X_2, of an individual on two parallel tests, t_1 and t_2, may be denoted by d. That is,

$$d = X_1 - X_2.$$

Next, the individual's true score on any test, t_j, can be denoted by T_j. If the parallel tests, t_1 and t_2, are a test and a retest, and there is no reason to believe that the individual has changed with respect to the attribute measured by the test in the interval between the test and the retest, then

$$T_1 = T_2 = T,$$

where T represents the individual's true score on the attribute measured by t_1 and t_2. Now, the deviation score x_j is defined as the deviation of an observed score X_j from a true score T_j, or as

$$x_j = X_j - T_j.$$

Consequently, the difference between two raw scores in the case of a test and a retest is

$$\begin{aligned} d &= X_1 - X_2 \\ &= (x_1 + T) - (x_2 + T) \\ &= x_1 - x_2. \end{aligned}$$

If the same test-retest has been given to a sample group of N persons, drawn at random from the same population as the individual subject, the differences between the N pairs of scores will fluctuate randomly by chance. If, then, a population of all such differences is defined, one can compute the variance of the differences between these N pairs of observed scores as

$$\frac{\Sigma d^2}{N} = \frac{\Sigma(x_1 - x_2)^2}{N}.$$

Substituting S_d^2 for the left-hand member and expanding the right-hand member of the previous equation yields

$$S_d^2 = \frac{\Sigma x_1^2}{N} + \frac{\Sigma x_2^2}{N} - \frac{2\Sigma x_1 x_2}{N}.$$

However, since (3, p. 95-96)

$$\sigma_x^2 = \frac{\Sigma x^2}{N}$$

and (3, p. 157)

$$r_{XY} = \frac{\Sigma xy}{N\sigma_X\sigma_Y}$$

then,

$$S_d^2 = \sigma_{x_1}^2 + \sigma_{x_2}^2 - 2r_{x_1x_2}\,\sigma_{x_1}\sigma_{x_2}.$$

For ease of notation, let

$$r_{12} = r_{x_1x_2}.$$

Now, assuming that the standard deviations of the test and retest are equal, and thus may each be denoted by σ_x,

$$\begin{aligned} S_d^2 &= 2\sigma_x^2 - 2\sigma_x^2 r_{12} \\ &= 2\sigma_x^2(1 - r_{12}). \end{aligned}$$

Taking the square root of both sides of this equation gives

$$\begin{aligned} S_d &= \sigma_x\sqrt{2(1 - r_{12})} \\ S_d &= \sigma_x\sqrt{1 - r_{12}}\,\sqrt{2} \\ &= S_e\sqrt{2}. \end{aligned}$$

Application of S_d

It is now apparent that in a case study one may test the significance of a given difference, d_k, in the usual manner by the use of a critical ratio which has the standard error,

S_d, as the denominator and d_k as the numerator. That is, an observed difference in an individual may now be compared with the standard error of the population of such differences to determine whether or not the size of the observed difference is greater than one would expect it to be if only random variations were operating. When S_d has been computed on a large N, normal curve tables may be used. For small samples, Student's Tables provide the exact random sampling distribution.

It should be noted that several basic assumptions underlie the use of S_d. In the first place, the variable must be normally distributed. Secondly, the standard error of measurement and the true mean of the group tested must remain constant during the interval of the test-retest period. Finally, one must assume that the subject being tested is a member of the same population as the group on whom S_d was computed.

Reliability Undetermined

At times, especially in pilot investigations, one may wish to use a test item, the reliability of which has not been adequately demonstrated. The researcher employing the case study technique may find it quite inconvenient, if not impossible, to test and retest a large sample group. Consequently, in such instances only one set of test scores will be available, and a coefficient of correlation, r_{12}, indicating reliability cannot be computed. Yet, without r_{12} there is no direct method of obtaining S_d. Nevertheless, this does not prohibit entirely the use of the technique presented in this paper. S_d can be estimated maximally from other data.

Guilford (3, p. 478) defines the index of reliability, r_{01}, as the correlation between true scores and obtained scores on a given test item. Therefore, r_{01}^2 is an index of determination denoting the proportion of the variance in the test scores which is determined by the variance in the true scores. The same information is given by r_{12}. Therefore,

$$r_{01} = \sqrt{r_{12}}.$$

Guilford (3, p. 479) also states, "Nothing can correlate with obtained scores higher than their correlation with corresponding true scores." That is, the maximum limit of the correlation of a test with anything else is r_{01}. Consequently, the coefficient of reliability for any test item, X, must be at least as great as the square of the correlation of that item with some other variable, Y. The use of the largest available r_{XY}^2 as a minimal estimate of r_{12} in the computation of S_d would be justified then so long as the investigator realizes that an overestimation of S_d results, thus increasing the severity of the test for significant differences. That is, a type II error of accepting the null hypothesis when it is false is more likely to be made (3, p. 210). Although in some instances statistical significance may be overlooked, this procedure strengthens the claim of significance for those cases in which it has been demonstrated mathematically.

Conclusions

Contrary to prevalent belief that data collected in a single-subject case study cannot be adequately treated statistically, the use of S_d as the denominator of a critical ratio enables one to evaluate the significance of observed differences in the standard manner. Where reliability has not been determined, it may be estimated minimally from the largest available correlation with some other variable.

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(Submitted 11/6/58)

Differences in Speed Between American Negro and White Children in Performance of the 35-Yard Dash

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THE PURPOSE of this study was to investigate the difference in speed between American Negro children and white children as measured by performance in the 35-yard dash. Subjects were in the fourth, fifth, and sixth grades. Observations of Negro and white children in the testing program administered by the author during the past four years of integration in the Kansas City public schools seemed to indicate that the Negro children were superior to white children in speed of running.

Some research has been done in exploring various differences between Negroes and whites. Brown (1), in his study of patellar reflex times, found that Negroes had a faster reflex. The mean patellar reflex time of 82 white subjects was .0861 ± .0013, while the mean patellar reflex of 81 Negro subjects was .0774 ± .0009. Lautenbach and Tuttle (2) found the correlation coefficient of .815 between speed in sprinting and reflex time. This may have some bearing on the speed of the Negro. In an earlier study, Westerlund and Tuttle (5) found the correlation coefficient to be .863 for the reaction time and speed in sprinting. In their study on the motor development of two groups of Negro infants, Williams and Scott (6) suggested that motor acceleration is not a racial characteristic. However, Metheny (4) noted differences in anthropometric measures on the college level. The differences between the anthropometric measurements of Negroes and whites indicated that the Negro should be a superior athletic performer.

Procedure

The subjects were 792 fourth-, fifth-, and sixth-grade boys and girls from five of the public elementary schools in Kansas City, Missouri. Of the total subjects, 390 were white and 402 were Negro. The test given the subjects was the 35-yard dash. This test for speed was chosen because it was one of the physical fitness tests given yearly in the school system. The distance was short enough that endurance was not an influencing factor. The subjects were given two trials, ten minutes apart. The faster trial was recorded.

Analysis of Data

The mean scores made by Negro and white subjects for the 35-yard dash are shown in Table 1. The Negro children had a lower mean score in all six groups, the largest difference being .61 seconds lower mean for fourth-grade boys. The lowest mean difference was .20 for the sixth-grade boys.

TABLE 1.—SUMMARY OF BASIC DATA FOR THE 35-YARD DASH

	N	Grade 4				Grade 5				Grade 6			
		Boys	N	Girls	N	Boys	N	Girls	N	Boys	N	Girls	N
Negro	402	5.76	84	6.28	84	5.72	72	5.98	66	5.62	46	5.68	50
White	390	6.37	78	6.58	68	6.11	62	6.40	71	5.82	57	6.12	54
Differences between Mean Scores		.61		.30		.39		.42		.20		.44	

TABLE 2.—SIGNIFICANCE OF DIFFERENCES BETWEEN MEAN SCORES OF NEGROES AND WHITES ON THE 35-YARD DASH

Grades	Sex	t	Level of Significance
Grade 4	Boys	4.207	.1%
	Girls	2.180	5.0
Grade 5	Boys	3.000	1.0
	Girls	4.444	.1
Grade 6	Boys	1.653	20.0
	Girls	8.663	.1

The t test was used to determine the significance of the difference in mean scores between the Negro and the white children. This formula for the significance of a difference in means of independent samples, as suggested by Lindquist (3) was used:

$$t = \frac{M_1 - M_2}{\sqrt{\left(\frac{N_1\sigma_1^2 + N_2^2\sigma_2^2}{N_1 + N_2 - 2}\right)\left(\frac{N_1 + N_2}{N_1N_2}\right)}}$$

The t's and the levels of statistical significance for the six groups are shown in Table 2. The differences between the mean scores of the Negro groups and the mean scores of the white groups were significant at the 5 percent level of confidence, or better. The exception was the sixth-grade boys' group at the 20 percent level, not statistically significant.

Conclusions

Differences in the mean scores of the 402 Negro children and the 390 white children used in this study indicated that the Negro children were superior in speed, as measured by the 35-yard dash, to the white children at three grade levels. To determine the significance of the obtained differences between the six groups, the t ratios were computed. The Negro boys had statistically significant faster times in the 35-yard dash at the fourth- and fifth-grade levels while the Negro girls had statistically significant faster times at all three grade levels. From the review of literature it would seem that the Negroes have a faster reflex which in turn correlates highly with faster times in sprint races. This may be a reason for the faster times turned in by Negro children in this study.

References

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(Submitted 1/23/58)

Utilization of the High Speed Electronic Computer

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IN RECENT YEARS numerous high speed electronic computers have become available to research workers in colleges and universities. As a result, the era of costly and time-consuming statistical computation by hand calculator is rapidly coming to a close. The great potential contained within these unbelievably fast machines, however, is yet to be fully realized. It is hoped that the discussion that follows may bring about a better understanding of their use and application.

In a survey conducted in 1951, Fattu (1) found that few computers existed in the country and those in operation were devoted primarily to national defense work. At that time there had been no use of these machines in the field of education. The first such use occurred on the Ordvac at the University of Illinois in December of 1951. Wrigley (2), in his summary of automation calculation, reveals the increase in computers by stating that in 1957 there were more than 1200 machines in the United States alone. Since then even more have been placed in operation.

Computers may be divided into two classes—digital and analog. A digital machine operates directly with numbers while the analog represents them by physical quantities. To illustrate, an abacus is digital whereas a slide rule is analogical. Since the analog is limited in accuracy, the digital machines have become more prevalent for use in education and psychology.

In the spring of 1958 the Electrical Engineering Department at Michigan State University completed work on Mistic, its high speed digital computer. It was built to the same basic design as the Illiac at Illinois, Silliac at the University of Sydney, and IAS at the Institute for Advanced Study. These schools co-operate in the exchange of programs and other materials. Although Mistic's primary purpose is to handle high order computations it is also extremely efficient in data processing. Like most computers it can merely do simple arithmetic, but tremendous memory capacity and speed of computation account for its effectiveness.

The first step in its operation is to feed in orders punched on a program tape. This information prepares the machine for the data which follow. After the data have been read in, the calculations commence and the results are punched out on IBM cards or tape, whichever is preferred.

The difficult part of this procedure is designing the program. Fortunately, however, many programs have been developed and can be secured from the Mistic library. Along

with the more complex mathematical programs the following ones for statistical analysis are available:

1. Analysis of Variance
2. Analysis and Intercorrelation of Scores Based on Paired Observations
3. Chi-square
4. Hotelling's Principal Axes Factor Analysis
5. Iterative Estimation of Communalities
6. Multiple Regression Analysis
7. Product Moment Correlations, Means, Standard Deviations, and Covariances
8. Quartimax Orthogonal Rotation of Factors.

Hence, a person need only prepare the data tape to make use of this time-saving device. The equipment needed for this is available in the tape preparation room. To begin the operation the data must be punched on tape. The tape is then run through a reader which prints out the data. This is necessary so accurate proofreading can be done to check the tape for errors. If errors are present, which is often the case, they must be located and marked on the tape. These are corrected through the use of a reperforater. This machine makes a new tape from the original and errors are removed by stopping the tape at the places marked and substituting the correction. The last phase is to run the original and corrected tapes through a comparer which stops when the two do not agree. If all of the errors have been corrected then it will stop only at the points where the corrections have been made. This being the case, the tape is then ready for Mistic. A copy of the desired program from the library is then made and, together with the data tape, is submitted for computation. When this is finished the results are run through the reader, and the answer is printed.

To illustrate how much time this whole operation takes, a typical problem will be discussed. The author, with no previous experience, conducted a correlation analysis involving 34 variables and 195 cases. The job of punching the data on tape took 12 hours. Due to inexperience many errors were made. As a result 30 hours were required for proofreading, reperforating, and comparing. This gives a total of 42 hours for data tape preparation. With a minimum of prior experience this could have been reduced to 20 hours, while an experienced operator could have completed the job in about 13 hours. Since the program tape was available no time was required to prepare it. Obtaining the intercorrelations of 34 variables requires 561 separate correlations. An experienced technician on a hand calculator could complete this work in approximately 600 hours. The time required by Mistic was 13 minutes. In addition to the correlation coefficients the means, standard deviations, and covariances were also computed during this time.

Eighteen of these variables were then selected for a factor analysis. The program for Hotelling's principal axes factor analysis (which, incidentally, is impossible to do on a hand calculator) was available. The correlation matrix of the 18 variables and their communality estimates were punched on tape in 20 minutes. Proofreading and reperforating took another 40 minutes and the data were ready for computation. The factor analysis was completed by Mistic in 8 minutes.

The services of this computer are available for use by faculty and graduate students at no charge. Also, each college within the university has a trained person available for consultation on the use of the equipment. If necessary the job of tape preparation can be hired out at a resasonable rate. This computer is also available for use by persons outside the university on a contract basis.

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(Submitted 3/30/58)

Testing Hypotheses

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A survey of the literature on the development of physical education tests reveals little of value to the researcher confronted with the problem of assessing the gross motor ability of manpower pools and predicting success in related tasks. Flexible instructions, subjective scoring, limited concepts of validity, and other factors involving a disregard or misinterpretation of principles of test construction have greatly reduced the usefulness of research in this field (1, p. 1).

THE ABOVE STATEMENT by three scientists outside of our field is rather startling in its blunt rejection of much of the work in one area of physical education research. That this survey contains over 140 references to reports in the *Research Quarterly* is indeed chilling.

It is, of course, possible to meet such criticism by concluding that it represents no more than the combined judgment of three individuals and that our research reports are probably no worse than those of other professional groups. This may salve our professional egos, but it would not be very profitable. It would simply demonstrate an unwillingness to admit the possibility that we have anything to learn from others, and it would indicate an inability to face criticism and profit from it.

It is probably an unpleasant fact that the above critical summary is largely justified. This is embarrassing, but we need not feel that the situation in physical education research is hopeless. Any fair-minded evaluation of our research will certainly note a steady and consistent improvement in quality through the years. Over the past decade, for example, there has been an enormous improvement in our understanding and appreciation of the possibilities in statistical analysis. We have got beyond the point where the accuracy of our calculations of a mean to four decimal places is considered to be equivalent to the accuracy of our knowledge about experimental variables. We have even got beyond the point where we are content to announce that "the smallest critical ratio of the difference between means for any question appearing on the revised test is 3.8, giving absolute assurance that the difference truly exists."

That we are not completely out of the woods in the statistical interpretation of data would seem evident from a scrutiny of our research reports over the past few years. A number of misinterpretations involving simple but basic principles appear to persist in our reports, and they are encountered with such regularity as to merit comment. The particular misinterpretation with which this note will be concerned involves the testing of hypotheses. For purposes of illustrating the nature of this misinterpretation, a recent report in the *Research Quarterly* will be considered.

In this report, which is concerned with the relative effectiveness of two swimming turns, the experimenters list the following "positive hypotheses tested":

1. That the somersault turn followed by the one-arm glide is faster than the somersault turn followed by the two-arm glide.
2. That the glide which follows each of these two types of turns may be slightly faster with a two-arm glide.
3. That the backstroke somersault turn followed by the one-arm glide is, overall, the faster maneuver to use in competitive backstroke swimming.

And following this presentation, which also includes an explanation for the directional bent of their hypotheses, the experimenters state: "In order to prove or disprove the positive hypotheses, data were compiled on two groups of swimmers." With reference to this statement, it may be said that general hypotheses can never be proved. When we test the significance of a difference between two means we never attempt to prove something; we only attempt to disprove something, and that something involves a null hypothesis of some particular kind.

For an understanding of the logic and technique of testing the significance of a difference between means, it is necessary (a) to appreciate the need for such testing, and (b) to distinguish between an experimental hypothesis and a null hypothesis. The need for such testing arises from the recognition that the observed effects of different treatments, or experimental conditions, will vary from one repetition of an experiment to another. That is, the results of any particular experiment are subject to sampling errors, and these errors introduce a degree of uncertainty into the interpretation of results. Such uncertainty keeps us from accepting the results of experiments at their face value.

In distinguishing between experimental and null hypotheses, the former may be said to determine the conditions and procedures under which observations are made; they are the experimenter's hunches which lead to the performing of an experiment. That they are inexact can be readily noted in the experimental hypotheses summarized above: one style of backstroke turn is hypothesized to result in "faster" or "slightly faster" swimming times than another. This vagueness and ambiguity precludes the possibility of applying statistical distributions, such as F, t, X^2, etc. For this reason an experimental hypothesis must be restated in the form of a null hypothesis. Through this restatement, the hypothesis is geared to the machinery of statistical distributions. This latter hypothesis is exact, as it must be if it is to be eligible for testing, and its exactness is based upon the supposition that the true difference between means has some specified value.

Most commonly, the specified value is zero, that is, the null hypothesis for the difference between two means will be $m_1 - m_2 = 0$, where m_1 and m_2 designate treatment means. On the basis of this assumption, the experimenter may then determine the frequency with which differences as large as those revealed by his experiment might be attributable to sampling error. Should his analysis indicate that a difference as large as that found in his experiment could be expected to happen very infrequently as a result of sampling error, he may then reject the hypothesis of no difference and accept the hypothesis that there is a difference between means. On the other hand, should the analysis indicate that differences as large as those found in his experiment could be expected to happen rather frequently as a result of sampling error, the experimenter would have no basis for rejecting his hypothesis of no difference. In this case, the conclusion would simply be that the experimental results do not contradict the hypothesis of no difference. By itself, this is a rather weak statement because the conclusion of no evidence against a hypothesis does not necessarily constitute satisfactory evidence in favor of the hypothesis.

Thus, a test of the signicance of a difference between means never involves proof or disproof of an experimental hypothesis; it only represents an attempt to discredit the hypothesis that the difference between means has some specified value. In a very real sense, we test the significance of a difference between means by setting up a dummy in the form of a null hypothesis, and we then try to batter it down with the club of a probability statement. And if we can succeed in this, it may then be possible to accept our experimental hypothesis.

Of course, a null hypothesis was used to assess the significance of differences between various swimming times, but the statement regarding the proof or disproof of "positive hypothesis" suggests that the experimenters misinterpreted the logic of their procedures.

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(Submitted 7/23/58)

Research Abstracts

Prepared by the Research Abstracts Committee of the National Council of the Research Section, D. B. VAN DALEN, Chairman

57. ADAMSON, J. PATRICK; LEWIS, LEON; and STEIN, JEROME. "Application of Abdominal Pressure for Artificial Respiration." *Journal of the American Medical Association* 169: 1613; April 1959.

A portable apparatus capable of aiding patients with various degrees of respiratory paralysis is described. A rubber bladder incorporated in an abdominal corset and operated by an electric pump provides the intermittent compression. A long, flexible tube connecting the bladder with the pump allows a certain amount for activities.—*P. V. Karpovich.*

58. ALEXANDER, A. ALLAN; KARPOVICH, PETER; and KEENEY, CLIFFORD. "Effect of Footgear upon the Energy Cost of Walking." *Industrial Medicine and Surgery* 28: 234; May 1959.

Eight types of American, British, and Canadian military boots and two types of American military dress shoes were used. Half of the American boots and shoes had two experimental changes incorporated in the design: either functional insole or ripple sole or both. Subjects walked at 3.45 miles per hour on a horizontal plane and 5-degree incline on a motor-driven treadmill. The experimental modification of the footgear construction made no change in the energy cost. There was no statistically significant difference in energy cost for any boot when walking was done under stress. Subjects unanimously commented on the feeling of comfort when wearing footgear with a ripple sole.—*P. V. Karpovich.*

59. BAUER, ADELIA C., and IMIG, C. J. "Blood Flow Through the Human Forearm Following Different Types, Intensities, and Durations of Exercise." *American Journal of Physical Medicine* 38: 48-52; April 1959.

Blood flow through the forearms of normal adult human subjects was measured before and after various intensities and durations of rhythmic and sustained hand-grip exercises. Although maximum levels of blood flow increase following sustained and rhythmic hand-grip exercises were similar, the blood flow following sustained exercises returned to, or near, the resting level at a more rapid rate than following rhythmic exercise. The maximum level of blood flow increase was proportional to the work done or to the total effort.—*C. Etta Walters.*

60. BEENKEN, HAROLD, and DUNN, F. LOWELL. "Short Distance Radio Telemetering of Physiological Information." *Journal of the American Medical Association* 169: 1618; April 1959.

A small transistorized radio transmitter weighing less than two pounds is described. It has a capacity for ten channels. Satisfactory transmission of an electrocardiogram was obtained from a subject walking on a treadmill.—*P. V. Karpovich.*

61. COGAN, MORRIS L. "The Behavior of the Teachers and the Productive Behavior of Their Pupils: I, Perception Analysis." *Journal of Experimental Education* 27: 289; December 1958.

This study was made to investigate the relationship between certain specific, observable behaviors of the teachers and the amounts of required work and class-related self-initiated

work performed by their pupils. Three crucial factors were involved in the research design: (a) Criterion measures were taken in terms of the amount of work performed by the pupils. (b) Clearly defined classroom behaviors of teachers served as independent variables. (c) Reliance upon reports of pupils was the most important source of information. Data were collected from 33 teachers, 5 principals, and 987 eighth-grade pupils in five public junior high schools. Individual pupils' ratings tended to differ for different teachers in perception of the teachers' behaviors and in the amounts of work performed. The principals' rating of teachers' behaviors was not consistently related to the pupils' rating of teachers. The teachers' estimates of their pupils required and self-initiated work were related to the pupils' own estimate of their work.—*D. B. Van Dalen.*

62. DeCrinis, K., and others. "Vasomotor Responses to Cooling in the Extremities." *Circulation* 19: 583; April 1959.

The upper extremity of healthy young adults, elderly noncardiovascular diseased adults, and groups of patients with spinal cord lesions was immersed in 15°C. water for 40 minutes. Vasomotor responses in the lower extremities were determined periodically.

The basal flows in the young normal subjects were higher than the healthy elderly group. In response to cooling the blood flow decreased 40 percent in both groups with the younger group reaching maximal response in 25 minutes and the older group in 45 minutes (thus, after cooling discontinuation). With patients having neurologic lesions, changes were in the same direction. The reflex response revealed "mirror images" of the warming stimulus. The hemiplegia did not interfere with the reflex. There was an increase in blood flow with the surgically sympathectomized. Normal responses seem dependent upon the sympathetic pathway integrity.—*E. D. Michael.*

63. Dreizen, Richard; Snodgrasse, Richard M.; Webbpeploe, Hamilton; and Spies, Tom D. "The Retarding Effect of Protracted Undernutrition on the Appearance of the Postnatal Ossification Centers in the Hand and Wrist." *Human Biology* 30: 253; December 1958.

The Ss were 541 (301 boys and 240 girls) undernourished native-born white Alabama children from similar ethnic backgrounds. Roentgenograms were taken at intervals of three months until a child reached his fifth birthday and every six months thereafter. Analysis of this study showed that (a) The mean time of appearance for each of 31 ossification centers was delayed in every instance. Boys were more delayed than girls in all but three centers. (b) The frequency of retardation in the onset of ossification surpassed the combined frequency of centers appearing either early or on schedule to a statistically significant degree for 29 and 26 of the 31 centers. (c) Some or all assessable centers were delayed in 504 of the 541 children. (d) The advent of ossification was more pronounced in the carpels than in the metacarpels and phalangeal epiphyses.—*D. B. Van Dalen.*

64. Friedman, Meyer, and others. "Changes in the Serum Cholesterol and Blood Clotting Time in Men Subjected to Cylic Variation of Occupational Stress." *Circulation* 17: 852; May 1958.

Accountants were studied for five months with the serum cholesterol changes followed biweekly and the blood clotting time monthly. There was a sensitivity of cholesterol to the occurrence of emotional stress described as "socioeconomic." Weight changes and dietary and exercise habits did not affect the cholesterol levels significantly. It appeared that the increase in time of clotting when under stress was a more important phenomena than cholesterol changes.—*E. D. Michael.*

65. Heidorn, G. H. "Pulse Pressure Response to a Standard Exercise Stress." *Circulation* 18: 249; August 1958.

The response of the pulse pressure to an exercise stress (the master 2-step) was noted when normal and myocardial infarction individuals were tested. It was found that the magnitude of the pulse-pressure rise immediately after the exercise was a differentiating

measurement. A rise of less than 12mm Hg or less than 25 percent was abnormal. It was also found that a lag in response, or a greater pressure at 1 minute after exercise than immediately after, indicated abnormal response.—*E. D. Michael.*

66. HELLEBRANDT, F. A. "The Physiology of Motor Learning." *Cerebral Palsy Review* 19: 9-14; July-August 1958.

This is an excellent review and discussion of the physiological and neurological aspects of motor learning.—*C. Etta Walters.*

67. HUMPHRIES, M., and SHEPHARD, A. H. "Age and Training in the Development of a Perceptual-Motor Skill. *Perceptual and Motor Skills* 9: 3-11; March 1959.

Three groups of children, ages 5½, 7½, and 9½, were trained on the reversed task of the Toronto Complex Coordinator. Training consisted of 3 sessions, each being 6 months apart. In each session, training was given in two 5-minute work periods and each period separated by a 20-minute rest period. Results indicated a relationship of level of performance to age as the oldest subjects made the most matches and fewest errors. Training progress showed a constant improvement in matches but no systematic change in errors. Reminiscence was the same for all age groups for all sessions. Data do not support the theory of the effects of previous experience on performance with unusual control-display relations.—*C. Etta Walters.*

68. KARPOVICH, PETER V. "Effect of Amphetamine Sulfate on Athletic Performance." *Journal of the American Medical Association* 170: 558; May 1959.

Fifty-four subjects were given a total of 532 tests in swimming, track running, and treadmill running to exhaustion. During the first half of the experiment subjects were given 10 mg. of amphetamine (9-10 mg. per 70 kg. body weight) one hour before the test. During the second half, 20 mg. of the drug (14-24 mg. per 70 kg. of body weight) was given 30 minutes before the test. Only four subjects showed definite evidence of the effect of amphetamine: three swimmers consistently swam faster with amphetamine than with a placebo, while one treadmill subject had more endurance with a placebo than with the drug. These four subjects received 20 mg. of amphetamine.—*P. V. Karpovich.*

69. KARPINOS, BERNARD D. "Height and Weight of Selective Service Registrants Processed for Military Service During World War II." *Human Biology* 30: 292; December 1958.

The findings of this investigation are the results of an analysis of height-weight data abstracted from about one-half million randomly selected physical examination forms. The registrants were within the age limits of 18 through 37, but primarily (about 40%) concentrated in the under-21 age group. The mean heights of the (18-37) groups were computed at 68.02 and 67.76 inches for white and Negro examinees respectively. The age group (20-24) had the highest stature. The mean weights were computed as 150.7 and 149.4 for white and Negro examinees. The Negro appeared somewhat shorter and lighter than white examinees. Examinees from the West and South Central regions proved to be taller, while examinees from the Northeast and North Central were the heaviest. Those from large cities appeared shorter and heavier, while those from small communities were taller and lighter. Higher socioeconomic scale appears to correspond with an increase in height and weight. Compared with the recruiter of World War I, the inductees of World War II seemed to be about 2/3 of an inch taller and about 10.7 pounds heavier.—*D. B. Van Dalen.*

70. KERSH, BERT Y. "The Adequacy of 'Meaning' as an Explanation for the Superiority of Learning by Independent Discovery." *Journal of Educational Psychology* 49: 282; October 1958. p. 282.

The purpose of this research was to test the premise that learning by independent discovery is superior to learning with direction because the learning is more meaningful

in the former case. Forty-eight college students provided the data. The Ss were required to learn two arithmetical tasks to a common criterion. Three "teaching" treatments (no-help, direct reference, and rule given) and two "number" treatments (A-form and X-form) were used in a two factorial design. Four weeks later a retest was given which demanded ability to recall and apply the learned rules to somewhat different problems. It was concluded that when the learner is forced to rely on his own capacities it is more likely that he will become motivated and continue the learning process until it becomes quite permanent.—*D. B. Van Dalen.*

71. LEVINE, JACOB, and ABELSON, ROBERT. "Humor as a Disturbing Stimulus." *Journal of General Psychology* 60: 191-200; April 1959.

An experiment was set up to test the hypothesis that the reaction of individuals to humor is related to their general level of anxiety. That is, people beset with anxiety symptoms will not respond to cartoons which tend to be more anxiety-arousing. Less anxious subjects will prefer humor that is at least mildly anxiety-arousing.

Thirty-one cartoons were used as humorous stimuli and they were rated by ten judges for their "disturbingness." Three groups of subjects were used—24 young Naval enlistees carefully screened for the submarine service; 45 hospitalized schizophrenic patients; and 27 acute hospitalized psychiatric patients with anxiety symptoms.

The findings generally supported the hypothesis. The patients disliked more of the humorous cartoons than the controls and expressed less positive mirth.—*Bruce L. Bennett.*

72. LIBET, B., FEINSTEIN, and WRIGHT, E. W., JR. "Tendon Afferents in Autogenetic Inhibition in Man." *Electroencephalography and Clinical Neurophysiology* 11: 129-40; February 1959.

The electromyograms of the anterior tibial and gastrocnemius muscles were studied with the muscle contracting at various lengths, and the mechanism of the changes was analyzed. In normal male subjects a maximal voluntary isometric contraction of the anterior tibial gave a lower (50%) EMG amplitude when the muscle was in a stretched position than when it contracted in a shortened position. The gastrocnemius, in the stretched position, gave an average reduction of 31 percent of that at intermediate length. Investigators tested the hypothesis that the lower EMG of the stretched muscle is due in part to autogenetic inhibitory afferent impulses from tendon organs by infiltrating with procaine the main tendon region of the anterior tibial. Results were a raising of the response of the stretched muscle to that of the shorter muscle. The role of autogenetic inhibition regulation of some normal motor function is discussed.—*C. Etta Walters.*

73. LIEBERT, ROBERT S., and RUDEL, RITA G. "Auditory Localization and Adaptation to Body Tilt: A Development Study." *Child Development* 30: 81; March 1959.

This study represents an effort to demonstrate that certain developmental changes which have been of considerable interest in vision have their parallel in audition. Thirty-six boys and 36 girls, ranging from 5 years 7 months to 17 years 6 months, served as subjects during two experiments. Experiment I was designed to test the prediction that central rather than peripheral mechanisms underlie the contrasting effects in the visual situation, and that the same general features should be found in other modalities. Ss were blindfolded and seated in a tilting chair to which the sound source was attached. Sound was directed from four starting points. Ten degrees and 30 degrees left and 10 degrees and 30 degrees right, always from an arc 12 inches from the occipital pole. The Ss were to tell the experimenter when the sound was directly above the midline of their heads. This procedure was repeated in 3 body positions, i.e., upright, 28 degrees left, and 28 degrees right. Experiment I found that older Ss committed errors of over-correction. The absence of this effect in younger Ss could mean that these Ss are more tolerant of abnormal body posture or else adapt to it more easily. This was the basis for the second experiment. In Experiment II the subjects were tilted six times for 15, 30, and 40 seconds, 28 degrees left and 28 degrees right. The Ss were then slowly returned to a position in which they felt erect. The results indicated that there was a continuous

decrease in the righting-self error with age. Both experiments indicated some central rather than peripheral explanation for the increasing compensatory displacement of stimuli opposite the position of the body.—*D. B. Van Dalen.*

74. MOREY, ROBERT H. *Morey Digests of Behavioral and Social Science Reports.* 1958. p. 287.

Observations of behavior, described in published reports, selected from thousands of specialized journals in the behavior and social sciences, are connected in Morey Digests to universal, root-habit modes of behavior. This method relates the many and varied actions in surface behavior to a few roots of all behavior; it classifies actions according to their common functions in satisfying human needs, extending and clarifying their meanings. Each digest is a summary of actions described in a published article. At the end of each digest is a brief description of reported behavior linked to root-habit modes of behavior. At the end of the digests is an index to Root-Habit Modes of Behavior. Four other indexes and tables help in locating particular items of information, and the original sources where full information may be found.—*D. B. Van Dalen.*

75. NACHMAN, MARVIN, and OPOCHINSKY, SEYMOUR. "The Effects of Different Teaching Methods: A Methodological Study." *Journal of Educational Psychology* 49: 245; October 1958. p. 245.

The subjects for this experiment consisted of two equated groups of 21 students each, one group in a small class of 21 students and the other group in large classes of about 140 students. The students in the small class were compared on an examination performance with the matched group in the large classes. The hypothesis was confirmed at the .01 level that the small classes would do better on quizzes which covered the classroom material and for which the students had not prepared, but that the two groups would do equally well on the final examination.—*D. B. Van Dalen.*

76. PADMAVATI, S., and GUPTA, S. "Blood Pressure Studies in Rural and Urban Groups in Delhi." *Circulation* 19: 395; March 1959.

The blood pressures of low and high income groups were studied in India and the variation of blood pressure with age and weight was determined.

With the low income group there was little rise in blood pressure with age except with increase in body weight. In the high income group the body weight and blood pressures were higher in every decade than in the low income group. There was a consistent rise in blood pressure with both age and weight. The low income group in every decade had lower systolic pressures than Western groups, while the diastolic pressures were lower after age 40.

The incidence of blood pressures over 140/90 was low among all classes of Indians. The lower body weight and weight gain appeared to be the important factor.—*E. D. Michael.*

77. SCHAEFER, L. E., and OTHERS. "Heredity, Environment and Serum Cholesterol." *Circulation* 17: 537; April 1958.

Serum cholesterol levels of 1236 healthy persons from 201 families were analyzed. The average serum cholesterol levels for males remained constant during ages 2 through 19, increased to age 32 where it remained constant to age 60. The levels for women remained constant through age 32 years and then increased to age 58. The annual increments were greater in men.

The data indicated that the genes for cholesterol levels are not sex-linked and that it is possible to identify members of hypercholesteremic families early in life. The role of environment appeared to play a less important role. The correlation between father and son was least and between mother and daughter was greater.—*E. D. Michael.*

Guide to Authors

IN LINE WITH the over-all goal of making Association publications yield the greatest value to the individual and the profession, the following is a guide for the preparation of manuscripts for the *Research Quarterly*, recognizing general techniques employed by educational research publications.

Manuscripts should be sent to the Managing Editor (AAHPER, 1201 Sixteenth Street, N.W., Washington 6, D. C.), who will see that each one is read by at least three members of the *Research Quarterly* Board of Associate Editors. On the basis of the three reviews, the Managing Editor will advise the author as to the suitability of the paper or the desirability for revision. Papers are judged on their content of new research results in the field of physical education, health education, and recreation, presented with the greatest brevity compatible with scientific accuracy and clarity. Manuscripts are considered for publication as articles or as notes or comments. For more detailed information, see "Criteria for Evaluation of Articles Submitted for Publication in the *Research Quarterly*," beginning on page 381.

Since three members of the Board of Associate Editors review an article, it is requested that three clear copies of the manuscript be submitted in order to facilitate reviewing. A fourth copy of the article should be retained by the author.

Typewritten manuscripts should be double spaced on white paper of ordinary weight and standard size (8½ x 11 in.). A brief abstract of the article, 100 words or less, should be typed double space on a separate sheet (see abstracts at head of *Quarterly* articles for style). The abstract should be a summary of the purpose, procedure, and findings of the study.

The sheets of manuscript should be kept flat. The pages of the typewritten copy should be numbered consecutively in the upper right-hand corner. Paragraphs should be numbered consecutively throughout the manuscript.

Headings

The headings should be typed so as to show relative values. Usually two gradations are sufficient: (a) major subdivisions of the article, aligned on the left and underscored in manuscript with wavy line; (b) subheads, underscored in manuscript and run in at the beginning of the paragraph or section. If it is necessary to use additional subdivisions, use subheads in capital letters, aligned on the left. If needed, this division should be inserted between a and b above (as demonstrated in this guide).

Documentation

FOOTNOTES

Footnotes are not to be used for references or literature citations. Rather they are used for the purpose of acknowledgment, special explanation, supplementary information, etc., as in the examples below.

Footnotes should be numbered from 1 up for each article, a corresponding numeral (placed above the line, like this [4]) appearing in the text. Asterisks should not be used. Type footnotes double space.

Examples of Footnotes. Following are examples of the kinds of footnotes which are acceptable:

[1]This study was made under the direction of Arthur T. Slater-Hammel in the Research Laboratories, School of Health, Physical Education, and Recreation, Indiana University, Bloomington, Indiana.

[2]All measurements of the hand were recorded in centimeters, and height was recorded in inches. The hand measurements were taken by Everett, and reliability coefficients of above .90 were found for each measurement used in the study.

[3]Appreciation is expressed to members of the Boston University varsity football squad and to Buff Donelli and his coaching staff for their co-operation in this study.

Tables often require footnotes. These should be identified by letters of the alphabet rather than asterisks.

CITATIONS OF LITERATURE

Citations of literature should be arranged alphabetically by author's last name. They should be typed at the end of the article, under the heading "References." *Do not treat them as footnotes.* Type references double space.

Numbering. The literature citations, arranged alphabetically, should be numbered consecutively, their location in the text being indicated by corresponding numbers enclosed in parentheses, for example (1), (2, 3). If there are several references in the text to a particlar publication, the specific pages may be indicated thus: (1, p. 117), (1, p. 162-63). The reference number in the text should immediately follow the title or author's name.

Uniform Style. A uniform style should be maintained in writing citations. Enclose titles of chapters and articles in quotation marks. Italicize (underscore in manuscript) names of books, periodicals, bulletins, etc. (See examples below.)

Uniform sequence of data should be observed, as follows: *For a book*—Author's name (last name first); title of article or chapter; name of book; place of publication; publisher; year date. *For a periodical*—Authors' name (last name first); title of article or chapter; name of periodical; volume number; inclusive page numbers; month and year date.

Alphabetization. When placing references in alphabetical order, last names beginning with "Mc" are treated like "Mac"; references by the same author are listed in order according to title; references by the same author with different co-authors are listed in order according to co-author.

Examples of References. Following are some samples incorporating the above principles. Note that author's first name should be given if possible and that all authors' names are reversed.

1. American Association for Health, Physical Education, and Recreation. *Health in Schools.* Washington, D. C.: the Association, a department of the National Education Association, 1951. 328 p.
2. Deaver, Gordon G. "Exercise and Heart Disease." *Research Quarterly* 26: 24-34; October 1955.
3. Deaver, Gordon G. "Weight and Heart Disease." *Physiological Hygiene.* (Edited by N. S. Long.) New York: McGraw-Hill Book Co., 1959. 469 p.
4. Ogden, Jean; White, Jess; and Smith, Wynn. *Small Communities in Action.* New York: Harper & Brothers, 1956. 250 p.
5. Potter, John Nicholas. *Physical Fitness of Junior High School Boys.* Unpublished Master's thesis. Berkeley: University of California, 1958.
6. Potter, John Nicholas, and others. "Comparison of Practice Periods in Learning." *Journal of Educational Psychology* 17: 150-62: July 1957.

Tabular Matter

Each table should have a descriptive heading and should be specifically referred to in the text by number, e.g., "Table 10," never as "the above table" or "the following table." Number tables from 1 up for the entire manuscript, using Arabic numerals. Do not duplicate data by giving them in *both* tables and graphs.

Tables should be typewritten double space, like the rest of the material in the manuscript. Each table should be typed on a separate sheet. If a table continues on a second sheet, it is not necessary to repeat the boxheads.

The word "table" should be written in capital letters, as "TABLE 1.—"; the table title should also be written in capitals, centered over the table. Tables should be ruled as desired, except that no rules will appear at the extreme right and left edges of the table. No double rules are to be used, unless necessary for clarity.

Illustrations

Illustrative material is of two types: pen and ink drawings, which are reproduced by the line engraving process; and photographs, wash drawings, stipple drawings (in short, anything containing shading), which are reproduced by the halftone process. All illustrative material (considered as figures) should be numbered consecutively from I up for the entire manuscript. Use Roman numerals to number figures.

Copy for Line Engravings. All drawings should be made with India ink, preferably on white bristol board plate, 1 ply or 2 ply. Avoid graph paper for the reproduction copy, as the printing interferes with proper inking and the paper permits no corrections. Sometimes it is desirable to ink in the principal guide lines so that the curves can be more easily read. Good examples of graphs can be seen in the *Research Quarterly* for May 1959, on p. 194-95.

Lettering should be plain and large enough to reproduce well when the drawing is reduced. Keep in mind the dimensions of the printed page (4⅛

x 7 in.). Most figures can be advantageously drawn for a linear reduction of one-half or one-third. Be sure to draw the lines heavy enough so that they will not be overly thin after reduction. Explanatory lettering should be included within the chart. Typewritten lettering does not reproduce well; it is much better to use a Leroy or similar lettering device.

Care should be taken not to waste space, as this means greater reduction and a less satisfactory illustration. Often it is possible to combine several curves in one figure and enable the reader to make comparisons.

Copy for Halftones. Photographs should be clear black-and-white prints on glossy paper. Care should be taken to see that they cannot be bent or folded in handling and mailing. ***Paper clips should not be used,*** for all imperfections are reproduced.

The legends for the illustrations should be clearly identified and typed on a separate sheet placed at the end of the manuscript. Care should be taken to indicate clearly in the text the location of all illustrations and tables.

Special Points of Style

Well-known statistical formulas should be omitted. Extensive tabular material, raw data, and appendixes should not be printed; the author can mention in a footnote that he will supply such material in mimeographed form on request.

Use of Numbers. Use Arabic figures for all definite weights, measurements, percentages, and degrees of temperature, e.g., 2 kmg., 1 in., 20.5 cc., 2 percent, 300° C. For numerals used in a general sense, spell out numbers through ten and use Arabic figures for 11 and over (seven times, five years old, 11 students.)

Abbreviations and Symbols. Standard abbreviations should be used whenever the weights and measurements are used with figures. All obscure and ambiguous abbreviations should be avoided. Percent should be one word. Use percent sign (%) in tables or when it appears in parentheses in text. Use standard symbols. Do not underline or put symbols inside quotation marks.

Proofreading

The author will receive his original manuscript and any engraver's proofs with the galley proofs of his article for correction. Corrected proofs and original manuscripts are to be returned within 48 hours after receipt by first-class mail to the Managing Editor, *Research Quarterly*, AAHPER, 1201 Sixteenth Street, N. W., Washington 6, D. C.

A reprint order blank will be enclosed with proofs. It should be returned whether or not reprints are wanted.

Criteria for Evaluation of Articles Submitted for Publication in the Research Quarterly

General Editorial Policy

1. Material suitable for publication shall include (a) reports of research studies, (b) reviews of research, (c) critical comment on published research, (d) descriptions of new research apparatus or techniques, and (e) abstracts and book reviews. Lists of theses or of bibliographical titles shall not be accepted.

(a) Research studies may utilize any sound method of investigation, e.g., experimental, historical, philosophical, survey. The research shall not have been published previously. Reports based on research for which the magisterial or doctoral degree has been granted shall be judged, for content and form, by the same criteria presented herewith for evaluation of other reports.

(b) Reviews of research shall be critical, comprehensive, and currently significant.

(c) Preliminary reports of research, critical comment on published research, and descriptions of new research apparatus or techniques shall be included in the Notes and Comments section of the RESEARCH QUARTERLY.

(d) Abstracts of research and reviews of scientific and scholarly books shall be included in a special section of the RESEARCH QUARTERLY.

2. Membership of the author in the AAHPER or in any other organization or institution shall not influence acceptance or rejection of a manuscript submitted.

3. Manuscripts of research reports and reviews and of material for the Notes and Comments section shall be reviewed independently by at least three associate editors whose familiarity and competence in the area of the research presented are well established.

Approval of at least two of the associate editors is necessary for acceptance. While the decision of the associate editors is final, provision should be made for reconsideration by the same or other associate editors if the author seems to have basis for appeal.

Material for the Research Abstract and Book Review section shall be reviewed by at least one associate editor.

4. Manuscripts accepted shall be published in order of submission. However, exceptions may be necessary if acceptance of the manuscript is depend-

ent upon revisions required by the associate editors and these revisions are not made promptly.

5. The author shall be notified by the managing editor at the time of acceptance of the approximate date of publication.

6. No changes, additions, or deletions shall be made in any article without approval of the author.

General Statement of Function of Associate Editors

The guiding principles of the associate editor in reviewing and judging manuscripts shall be (1) to maintain a high standard of scholarship in the publication and (2) to encourage and assist research workers in meeting these standards.

The associate editor should be competent in the area of study of the manuscript under consideration—familiar with factual data and with research methods and tools available; sensitive, open-minded, and critical in recognizing new ideas and methods and in evaluating new data. He should be thoroughly objective and impartial in his review, basing judgment solely upon evidence presented, not upon opinion of either associate editor or author. He must recognize and control an almost inevitable human tendency to bias and avoid any hint of censorship in his judgment.

The associate editor should be alert in recognizing intrinsic merit and potentially valuable contribution in a study which may be poor in its presentation or incomplete in its development. A constructive, sympathetic attitude on the part of the associate editor, with positive suggestions to the author for revision or extension of either the report or the research represented, will help to salvage both the accomplished research and the worker. An overly harsh attitude may lose both to the profession.

The associate editor in accepting his appointment should be fully informed and aware of the responsibility involved and the importance of carrying out his assignments not only with good judgment and fairness but also with dispatch.

If an associate editor does not feel adequately qualified to review a particular article, he should return the article to the managing editor immediately, with recommendation that it be referred to another associate editor for review.

If for any reason he is unable to devote the necessary time and effort to do good reviewing promptly, he should take the initiative in resigning as associate editor.

Specific Criteria for Evaluation with Respect to Content

1. The merit of the research article shall be judged in terms of its contribution to knowledge and to development of theory, either as new information, substantiation, or contradiction of previous findings or application of new or improved research techniques to old problems. It should be recognized that pioneering research may sometimes be concerned with the securing of basic data, which may afford a basis for the later development of theory.

2. The subject matter should be pertinent to health, safety, physical education, and/or recreation, either as applied or basic research.

3. The data presented should warrant a reasonably definite conclusion, i.e., should not be merely a progress report. However, the extent or comprehensiveness of research reported should not be the sole basis for acceptance or rejection; a report of the early stages of a research study may be valuable for the information per se and/or as a guide to other workers.

4. Good scholarship should be evidenced both in the design and execution of the study and in the interpretation of the data presented.

Following is a suggested list of important elements in a well-conducted investigation:

(a) The problem is significant, related to the development or refinement of theoretical principles and/or the testing of hypotheses.

(b) The problem is adequately delimited and the specific purposes of the research are clearly stated.

(c) The methods used are appropriate and adequate to yield data necessary for the solution of the problem.

(d) The methods and procedures used in collecting the data are clearly described with evidence of precision of measurement included, whenever reasonable.

(e) If the problem is such that quantitative analysis of the data is indicated, the statistical methods used are appropriate and adequate.

(f) In an historical study, accuracy, thoroughness, objectivity, and sound logic should be evidenced in the collection, analysis, and synthesis of the data. Emphasis should be on analysis, synthesis, and interpretation, rather than on mere reporting.

(g) A philosophical study, dealing with values or new concepts, should be based on a thorough, logical, cogent, and creative development of rationale. It should be developed in relation to a clearly stated hypothesis. It should not be merely superficial speculation. It should avoid "circular reasoning."

(h) In a survey study, emphasis should be on exposition and analysis, with particular attention to conceptualization and the appropriate selection and adequate sampling of the relevant population. The significance of the findings for diagnosis, policy, or program should be indicated and justified.

(i) In all studies there should be adequate documentation; the data should lead to a definite set of conclusions; the conclusions and interpretations should be based upon and supported by the data presented. Relevance of the findings to theory and to the testing of hypotheses should be indicated. Discussion or theorizing should be clearly identified as such.

(j) For a more extensive guide to evaluation, reference may be made to Carmichael[1] or similar source.

5. Review articles shall be judged on the bases of current significance of the subject matter, comprehensiveness, and the quality of critical analysis and skill in integration shown by the author.

6. The Notes and Comments section provides opportunity for brief reports, not exceeding 500 words, of a preliminary study or of an observation or finding, which might have been incidental to another study or one which the author does not intend to pursue further. This section may also serve as an

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[1] L. Carmichael, *Manual of Child Psychology*, New York: J. Wiley and Sons, 1946.

open forum for brief, objective, well-considered, critical comment on research previously reported in the RESEARCH QUARTERLY, and for the author's reply to such comment.

Clear, concise descriptions and/or diagrams of new research apparatus or techniques developed by the author, or generally inaccessible, are suitable for inclusion in this section, provided that reasonable demonstration of their value is given. Apparatus and methodological articles are not necessarily limited to 500 words.

7. The Research Abstract and Book Review section is designed for the brief presentation of pertinent research material from other publications, both foreign and domestic, in physical education and related fields of study. Abstracts of degree dissertations may be included here.

Specific Criteria for Evaluation with Respect to Form and Organization

1. Material shall be presented in a clear, logical, orderly, objective way.

2. Manuscripts submitted shall conform in technical details to the form prescribed by the managing editor. A description of technical details, i.e., bibliographical form, tables, illustrations, kind of paper, etc., shall be formulated by the managing editor, with the advice of the Research Quarterly Advisory Committee, and given adequate publicity.

3. The material shall be presented in the briefest form consistent with clarity, accuracy, and completeness. Standard statistical formulas should not be given; commonly used techniques should not be described in detail.

4. Correct use of language, as well as a certain dignity and objectivity in literary style, shall be expected.

Committee on Criteria for Evaluation of Articles Submitted for Publication in the Research Quarterly
Karl Bookwalter
David K. Brace
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Franklin Henry
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Lawrence Rarick
Pauline Hodgson, *chairman*

March 1959

New Membership Classification for AAHPER

Do You Qualify?

The 75th Anniversary Year of our Association is a most appropriate year in which to introduce a new and distinguished membership classification. At the AAHPER national convention in Portland, Oregon, the Representative Assembly approved a membership classification which will honor those AAHPER members who qualify for this recognition. The new membership classification is entitled Fellow.

All AAHPER members who have been paid-up members for five consecutive years at the time of application may request a Fellow Application Form from the national headquarters office. (Years of membership as an undergraduate student do not apply.) The application form requests both detailed information about professional service and three endorsements. Members' credentials, as presented on the completed application form, are carefully reviewed. The cost of this membership is $15.00.

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All interested members who have satisfied the five-year requirement are invited to make application for the recognition of Fellow in the American Association for Health, Physical Education, and Recreation. Write to AAHPER, 1201 Sixteenth St., N.W., Wash. 6, D. C., for the Fellow application forms

Check List of AAHPER Research Publications

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